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VISITORS' GUIDE

TO THE

Geological and Palæontological Collections

IN THE

American Museum of Natural History

CENTRAL PARK, NEW YORK CITY.

77th St. and 8th Ave.

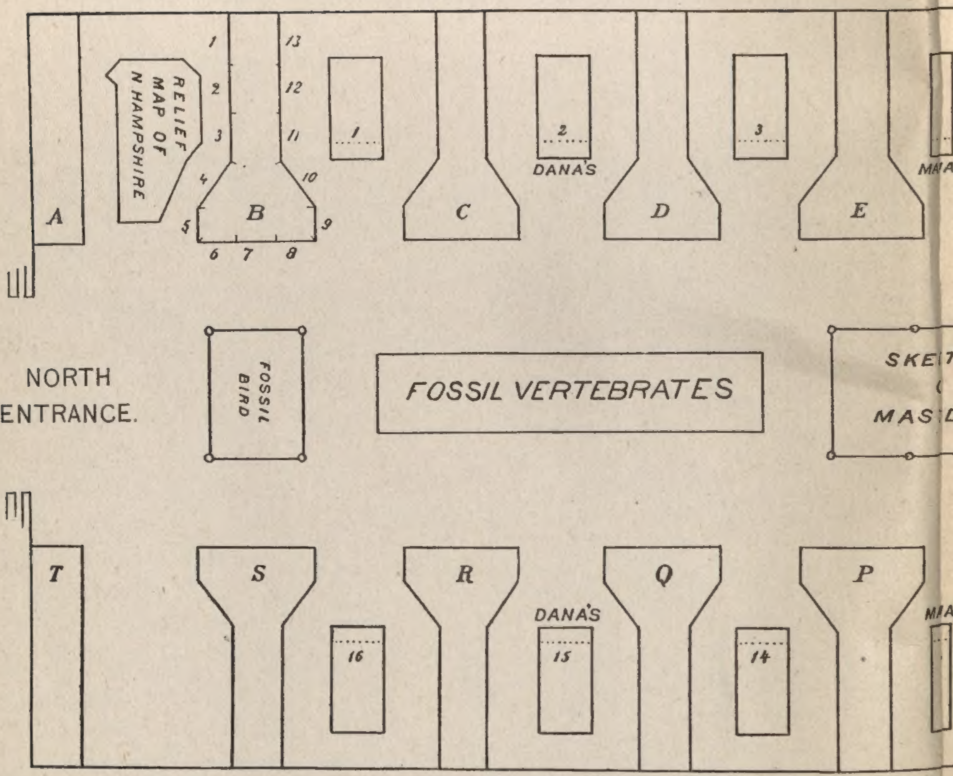
FOURTH EDITION.

PRINTED FOR THE MUSEUM.

PRICE, FIFTEEN CENTS.

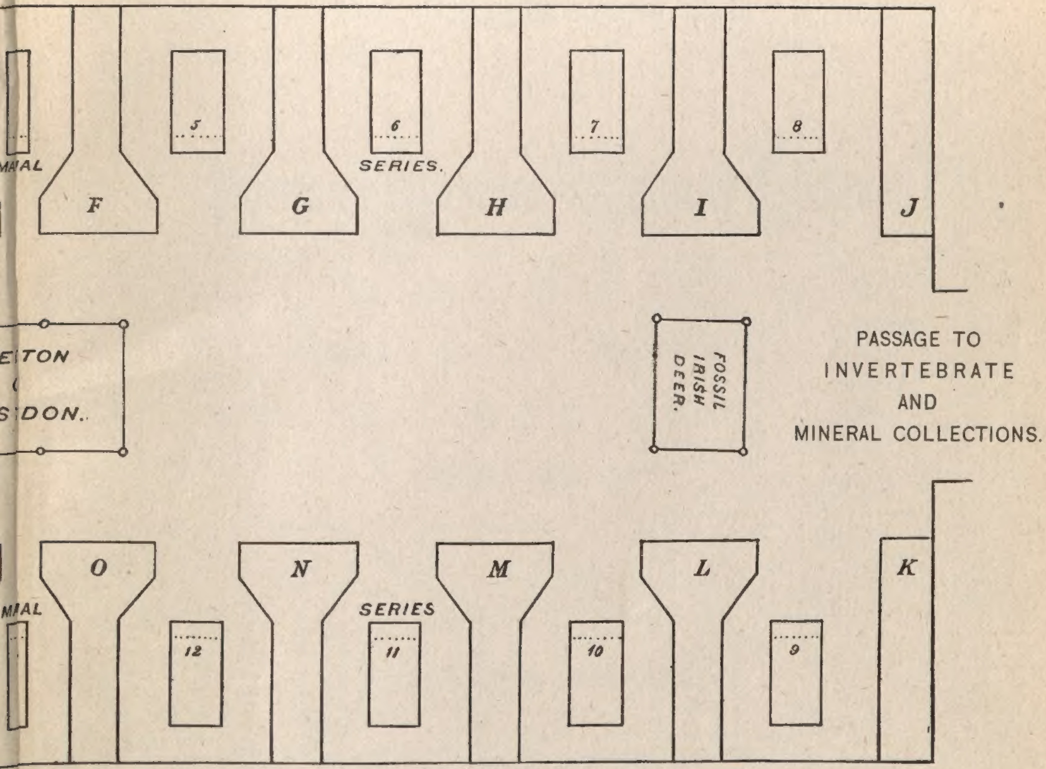
AMERICAN MUSEUM
CENTRAL PARK
NEW YORK
OF NATURAL HISTORY

DIAGRAM OF THE



This diagram shows the position of the Cases by letter and numb
of the large Cases are numbered the s

GEOLOGICAL HALL.



b as referred to in the Guide, the top being the East. The sections
ne in each. See Case B on diagram.

AMERICAN MUSEUM
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TO THE

GEOLOGICAL AND PALÆONTOLOGICAL COLLECTIONS

IN THE

American Museum of Natural History,

Seventy-seventh Street and Eighth Avenue,

NEW YORK CITY.

R. P. WHITFIELD, CURATOR.

NEW YORK:
PRINTED FOR THE MUSEUM.

1892.

Collections in the Geological Hall.

The collections exhibited in this hall consist of fossil organic remains from the rocks of the different geological formations represented in America, together with rock specimens and specimens illustrating different phenomenal features. These objects are arranged in the cases chronologically, *i. e.*, according to geological time, beginning at the northeast corner of the room with the oldest or lowest formations, and passing around the room from left to right, thus passing from the lower or oldest to the higher or newer beds ; the organic remains under each division being those found in the formation indicated by the large label in the top of the case. The cases are lettered and numbered, the letter being under the gas bracket at the end of the case, and the panels numbered over the door.

DESCRIPTION OF THE COLLECTIONS.

GEOLOGICAL COLLECTIONS.

GEOLOGICAL SKETCH.

Geology teaches us the structure of the Earth, how it was formed, the different phases through which it has passed, and with *Palæontology* (a study of the fossil organic remains found imbedded in the rocks) gives us a record of the different events in its history, and of the various races of animals and plants which have lived on its surface, or in its seas. It also aids us in finding the home of the various metals, coals, salt, building stones, and other substances of economic importance which the earth contains.

It shows us that the outer portion of the earth's substance is made up of a succession of layers of rock of different kinds and composition, superimposed one upon the other like the layers of brick or stone in the walls of a building, and that although at the present time they are mostly covered by loose surface material, as soil, sand, gravel or clay, and this again by a coating of vegetation, that wherever the experiment may be tried, rock in beds is found within a few feet, or a few hundred feet of the surface. The structure of the rocks shows us, that, except in the case of volcanic rocks, they were made up of deposits of various kinds formed under water, as they are regularly stratified, or composed of thin beds, although in many places they have been changed by some subsequent action. In consequence of these varying conditions, they have been classed under two principal heads, namely, *Stratified* and *Unstratified.*

The **Unstratified** rocks comprise all volcanic rocks, such as lavas, traps, basalts, &c. The Palisades, on the Hudson River, and the Giant's Causeway, in Ireland, are examples of this kind.

The **Stratified** rocks are classed as *Metamorphic* and *Non-metamorphic.* The former are those which have been changed by some action subsequent to their original deposition, so as to partially obliterate their original structure. These are often called also *Crystalline rocks.* The rocks of New York Island are examples. Granite, gneiss, roofing slate and statuary marble belong here. These crystalline rocks being the lowest, and consequently the oldest, formed a floor upon which the more recent ones were deposited. They also contain many forms of minerals and metals, especially iron (see Case A).

The **Non-metamorphic** divisions of the stratified rocks are those which afford the great interest to students of geology, as being those which present, in their fossil contents, a record of the past history of the globe since the commencement of life on its surface. The character of these rocks shows that they at one time formed the bed of the ocean, and are made up of the sediments from the water, together with the remains of different forms of animal or plant life that existed at the time the deposits were made, and in that way preserve a record (as fossils) of the beings which existed in the seas at that time. As they lie one upon the other in regular order, the lowest being of course the oldest, each successive bed, from below upward, would record the events of a succeeding period of time ; and as these periods and epochs are divided according to their fossil contents, they represent the different stages of the earth existence, by the history as recorded therein.

By subsequent changes, which took place in the level of the earth's surface, these rocks, together with their contents, were raised to their present position, and again partially worn away. They are now seen protruding from beneath the surface covering of soil, sand, gravel or clay, and are exposed to view on the sides of hills, or along ravines, where they are cut through by streams ; and as the various beds differ in composition or in their mineral or fossil contents, they can be traced and mapped as roads or streams are. In this way geological maps are constructed which show by their colors over what part of a country any certain rock forms the surface, beneath this superficial covering.

There are several divisions of geological science, as Dynamical, Chemical, Mining, Economic, Geographical, Historical, &c. The collections in this room are illustrative principally of *Historical* and *Geographical* geology, although minerals and other economic products are slightly represented and will be increased as collections are obtained.

Geological Names.—During the early study of the geological formations, it became necessary to apply names to the different beds and groups of beds, in order to classify them and study their relations to each other and to those of other countries. This gave rise to a GEOLOGICAL NOMENCLATURE, which is based partly on the organic remains (*fossils*) found in the rocks, and partly upon the localities where studied or where best developed; and a few have reference to the nature of the rock itself. The first series of names is that of EPOCHS, and serves to designate small groups of strata of limited extent, characterized by peculiar species of fossils confined within the epoch. These epochs are grouped under PERIODS which have a wider signification, both in time, in the geographical distribution of the rock, and in their fossil contents. The next larger grouping is under AGES. These are named from the prevailing type of life existing within their limits, as the *Age of Reptiles*, *Age of Mammals*, &c. The largest grouping has reference to the times of the earth's history and the forms of life represented, as *Eozoic time*, or time of the dawn of life, &c. The names of epochs and periods below the Carboniferous age, are those adopted by the New York geologists during the survey of the state, and are those most generally used in this country. Many of the others are of European origin.

The accompanying tabular section, Fig. 1* (copied from *Dana's Manual of Geology*, with a few changes only), illustrates the geological nomenclature and classification. The succession, as given under the Reptilian age, is mostly European, the American rocks of these periods not being fully understood at present. The horizontal section, Fig. 2, is an ideal one from Northern New York to Pennsylvania, showing the succession and superposition of the formations in New York.

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* A very large proportion of the cuts used in this Guide are taken from *Dana's Manual of Geology*, the author and publishers of which very kindly furnished electrotypes, at the cost of production, for this use. Others are copied from various works.

TABULAR SECTION OF FORMATIONS.

Fig. 1.

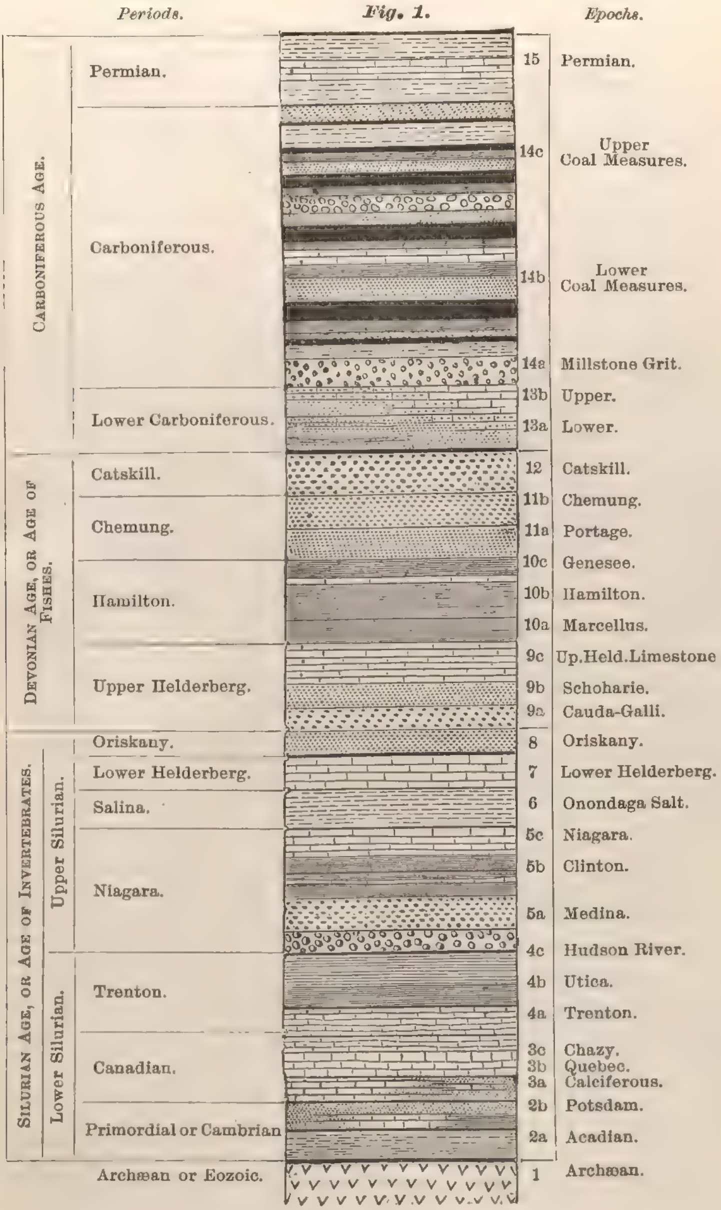


Fig 1. (*continued*).

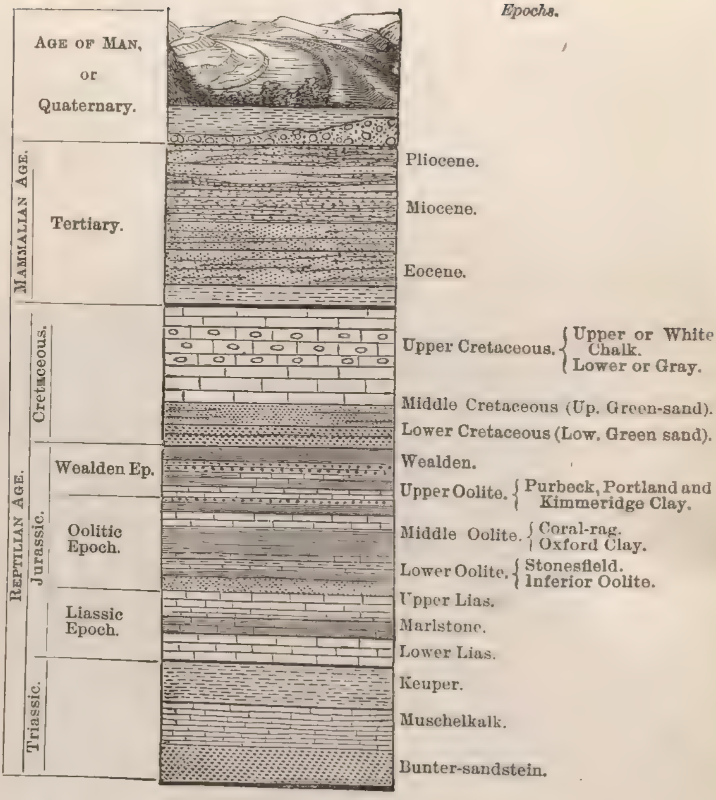
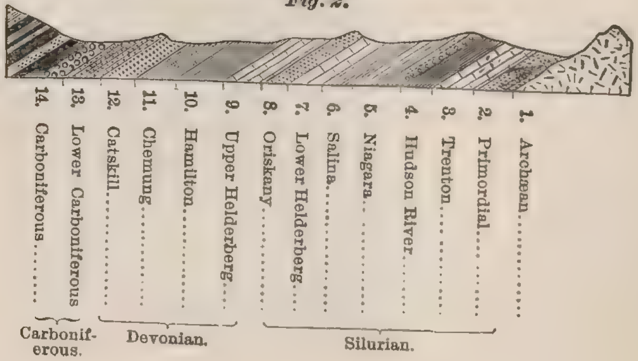

Epochs.
AGE OF MAN, or Quaternary.
MAMMALIAN AGE.
Tertiary.
Pliocene.
Miocene.
Eocene.
REPTILIAN AGE.
Cretaceous.
Upper Cretaceous. { Upper or White Chalk. Lower or Gray.
Middle Cretaceous (Up. Green-sand).
Lower Cretaceous (Low. Green sand).
Jurassic.
Wealden Ep.
Wealden.
Oolitic Epoch.
Upper Oolite. { Purbeck, Portland and Kimmeridge Clay.
Middle Oolite. { Coral-rag. Oxford Clay.
Lower Oolite. { Stonesfield. Inferior Oolite.
Liassic Epoch.
Upper Lias.
Marlstone.
Lower Lias.
Triassic.
Keuper.
Muschelkalk.
Bunter-sandstein.

Fig. 2.



Palæontological Collection.—This term (Palæontology) is applied to a collection of the *fossil organic remains* found imbedded in the rocks, and means a study of, or discourse upon ancient life. The collection of these objects in the Hall is arranged on the four lower shelves of the large cases, and in the table cases in the alcoves. It is the richest and most extensive collection of American invertebrate fossils in the world, and contains nearly seven thousand type and figured specimens. The most of these (the Hall Collection) are described and illustrated in the volumes of the New York Natural History; the Annual Reports of the Regents of the University on the New York State Cabinet of Natural History; the Iowa and Wisconsin Geological Reports; the Fossils of South Carolina, by Tuomey & Holmes; and some have been published in the Bulletins of this Museum.

Fossils are the remains of plants or animals that once lived in the ocean, or were washed from the land into the ocean. As the animals died, their remains were buried in the mud at the bottom of the ocean, and are now found preserved in the rocks formed of that mud. Rocks formed under water, as above described, would necessarily contain any hard or solid body living and dying in the ocean or on its bottom; we consequently find sea-shells, corals, bones of fishes, &c., imbedded in them, so that they are made to contain the record of the animal and plant life of the seas at the time and place where they were formed. Fossils formed in this manner, of dead material, often drifted by ocean waves and currents, must be necessarily much broken, and generally imperfect, as well as often obscured by adhering rock. As the succession of the beds of rock, from the lowest upward, is progressive in time, the record of life is also progressive, and shows the advance in structure through the successive stages. We also find that after a certain form has once appeared in the record, and has passed out of existence, it is never repeated. Consequently by understanding the life record of the various formations, we are enabled to determine to what part of the geological record a particular bed belongs, by determining the character of its enclosed fossils. We also find that the different forms of animal and plant life come into the geological record nearly or quite in the same order as they stand in the scale of organization; that is, that the first in the geological record are of low type, and as we advance in the record, higher types make their appearance This will be seen and understood by reference to the tables of Life Records, Figs. 3 to 7, on pages 16-20, copied from *Dana's Manual of Geology*.

CLASSIFICATION OF FOSSILS.

Scientific Names.—Objects of Natural History are of such general interest to all civilized people, that it long ago became necessary to designate them by name, that they might be spoken of or written about understandingly, and be recognized by people of different countries and tongues without confusion: this required that the names should conform to some fixed plan. Previous to the time of Linnæus (about the middle of the 18th century) common names or descriptive sentences were usually applied. These were often so long and complicated as to be unintelligible or very cumbersome. To avoid this, Linnæus proposed to use a binomial (double name) system, constructed of Latin or Greek words; these languages being commonly understood by scholars in all countries. This plan has been universally adopted by all writers, with an additional precaution of never applying the same name to different objects within the same sub-kingdom. In this way has arisen a system of classification, composed of a series of names which are applied to groups of animals or plants of greater or less value, but which recognizes the relations and affinities which one animal or plant bears to another, depending principally on their structure and the perfection of their various organs in their adaptability to the purposes of life. These divisions are: first *Species*, individuals of the same kind; then *Genera*, *Families*, *Orders*, *Classes*, *Provinces* and *Sub-kingdoms*.

The use of some such classification is indispensable in arranging collections of fossils to illustrate geological history. The classification used in this collection is first GEOLOGICAL, according to epochs, and under this, according to LITHOLOGICAL areas (mineral composition of the rock), which is also to some extent geographical. Under each of these divisions there is an independent ZOÖLOGICAL classification of the fossils, passing from the lowest to the highest, that is, according to their zoölogical affinities, which is found to be nearly in their order of appearance in geological time.

HOW TO TRACE THE CLASSIFICATION.

On entering the room turn to the left, and in following along the cases follow the geological succession from the lowest, or oldest formation, in Case A, around the room to the top, or newest of the American series in Case Q; beyond which European and other fossils are arranged. The Geological Epochs are marked by signs suspended in the cases at the beginning of the series representing that epoch, and are arranged in regular order from Case A, in the order given in the Tabular Section, pages 11 and 12, beginning with the lowest, 1, Archæan, and following around the room, always reading from left to right. The lower four shelves contain the fossils, and the two upper, rock specimens illustrating it. The classification of the fossils is indicated by printed labels, giving the name of the division under it, with its meaning; the size of the type indicating the rank of the division. The species labels are placed within the trays or over them, and are written labels. The arrangement is as yet only partially made, and where not fully completed, the written specific labels only are given under each division,* but where complete, contain the generic and specific name of the specimens under it, the name of the author of the species, a reference to the work or volume where published, if a type or figured specimen, and the locality where obtained; the geological formation being indicated by the epoch sign under which it is arranged, or sometimes on the label itself, as follows:

No. **(TYPE) AM. MUS. NAT. HIST.** Hall. Coll.
Dendrocrinus longidactylus, Hall.
Pal. N. Y. Vol. 2, p. 193, Pl. 43, fig. 1 a-k.
Niagara group.
Lockport, N. Y.

The classification is further indicated by strips of colored wood, separating the fossils of a division from the next, as follows. A single black strip separates *Species* of the same genus; a red strip *Genera* under the same family; a white strip *Families* under the same order; two white strips separate *Orders*, and two black ones *Classes* or higher divisions. Green tickets on, or by the side of a specimen, indicate one that has been used in the original description of the species (type), or has been described and figured in some published work on the subject, to illustrate a previously described species (figured specimen).

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* The complete arrangement of the collections will be made as rapidly as possible, but will require considerable time; preliminary labels will, therefore, be placed with the species as fast as the cases can be finished. Persons wishing special information about certain forms, can apply to the Curator.

LIFE RECORDS.

The times of the first appearance, in geological history, of the different groups of animals and plants, as well as their increase and decrease during the several ages, is partially represented by the following diagrams, taken from *Dana's Manual*. The first diagram gives a general view of the *Animal* and *Vegetable* kingdoms, from their first appearance to the present time; the next three give the origin, development and disappearance of *Animal* life during Palæozoic time, and the last, that of the *Vertebrate* kingdom from the close of Palæozoic time to the advent of Man.

The initial point of the shaded area, representing any form of life, indicates its first appearance in the geological record at that period. The breadth of the area shows its greater or less development during the successive epochs or ages while it existed. The ages and periods being marked at the top, except in Fig. 3, where they are on the margin.

Fig. 3.

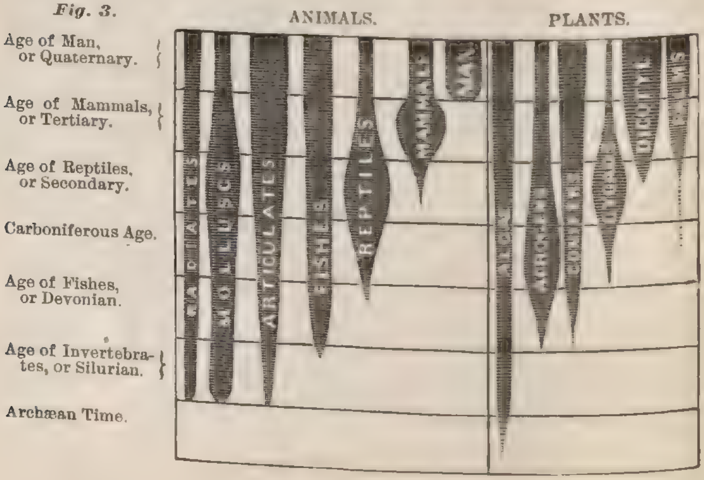


Fig. 4.

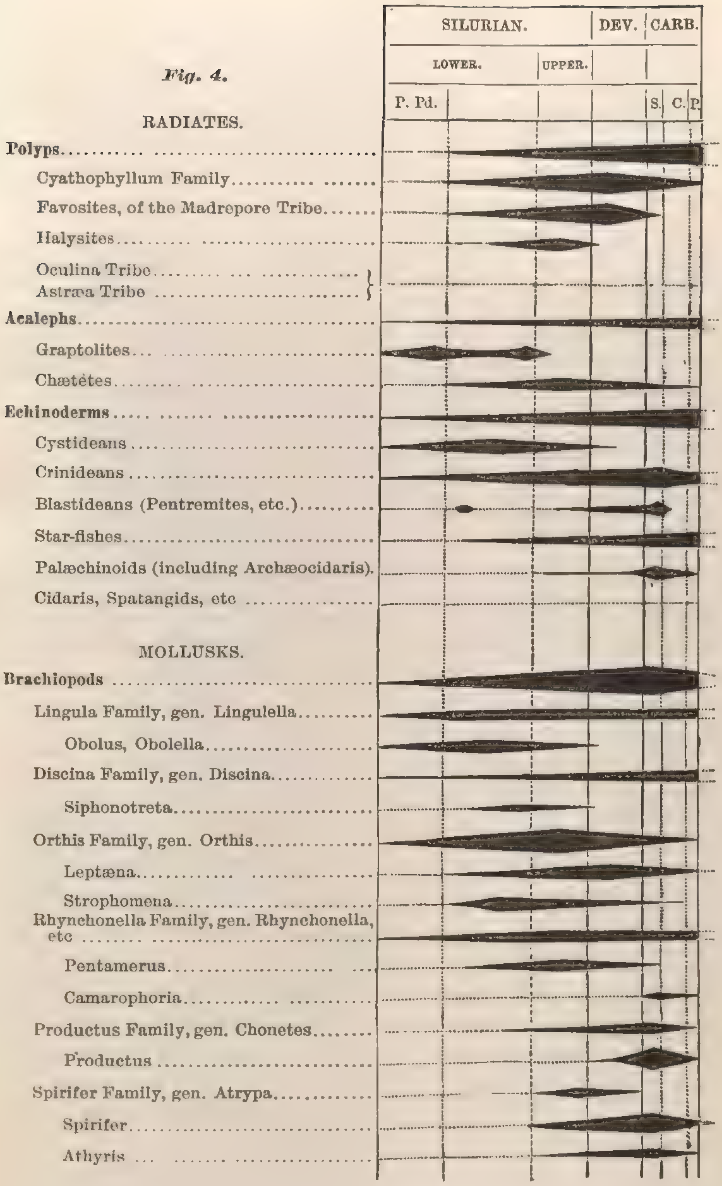

SILURIAN.
DEV.
CARB.
LOWER.
UPPER.
P. Pd.
S.
C.
P.
RADIATES.
Polyps
Cyathophyllum Family
Favosites, of the Madrepore Tribe
Halysites
Oculina Tribe
Astræa Tribe
Acalephs
Graptolites
Chætètes
Echinoderms
Cystideans
Crinideans
Blastideans (Pentremites, etc.)
Star-fishes
Palæchinoids (including Archæocidaris).
Cidaris, Spatangids, etc
MOLLUSKS.
Brachiopods
Lingula Family, gen. Lingulella
Obolus, Obolella
Discina Family, gen. Discina
Siphonotreta
Orthis Family, gen. Orthis
Leptæna
Strophomena
Rhynchonella Family, gen. Rhynchonella, etc
Pentamerus
Camarophoria
Productus Family, gen. Chonetes
Productus
Spirifer Family, gen. Atrypa
Spirifer
Athyris

Fig. 5.

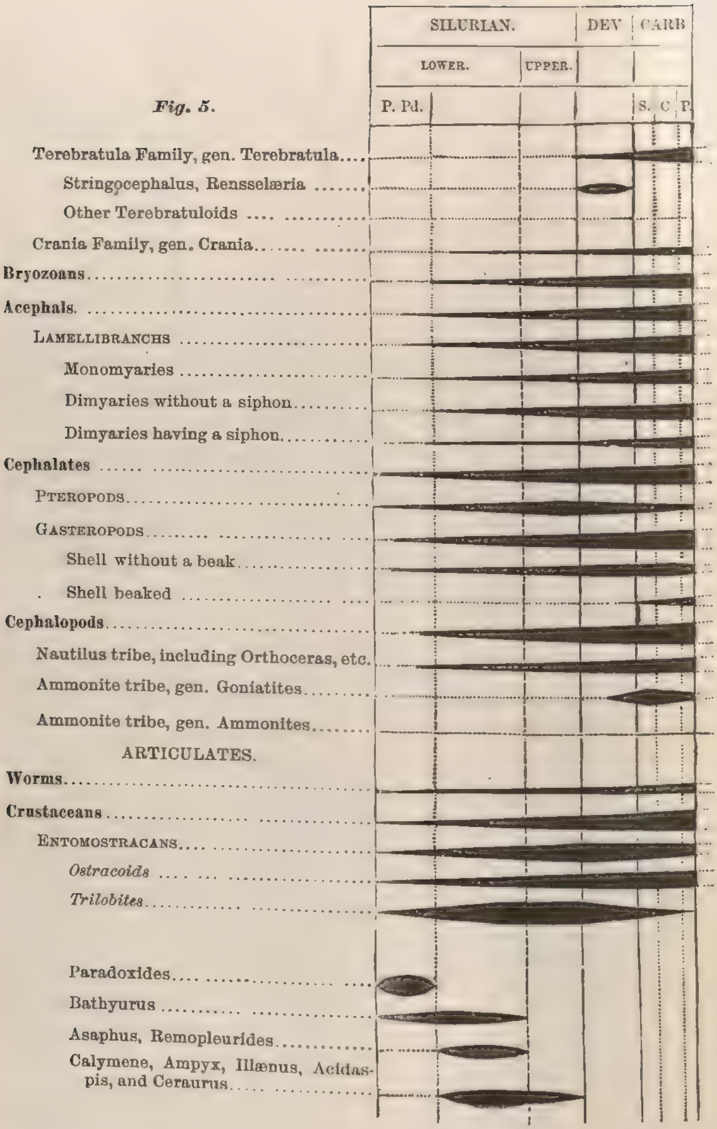

SILURIAN.
DEV
CARB
LOWER.
UPPER.
P. Pd.
S.
C
P.
Terebratula Family, gen. Terebratula
Stringocephalus, Rensselæria
Other Terebratuloids
Crania Family, gen. Crania
Bryozoans
Acephals.
LAMELLIBRANCHS
Monomyaries
Dimyaries without a siphon
Dimyaries having a siphon
Cephalates
PTEROPODS
GASTEROPODS
Shell without a beak
Shell beaked
Cephalopods
Nautilus tribe, including Orthoceras, etc.
Ammonite tribe, gen. Goniatites
Ammonite tribe, gen. Ammonites
ARTICULATES.
Worms
Crustaceans
ENTOMOSTRACANS
Ostracoids
Trilobites
Paradoxides
Bathyurus
Asaphus, Remopleurides
Calymene, Ampyx, Illænus, Acidaspis, and Ceraurus

Fig. 6.

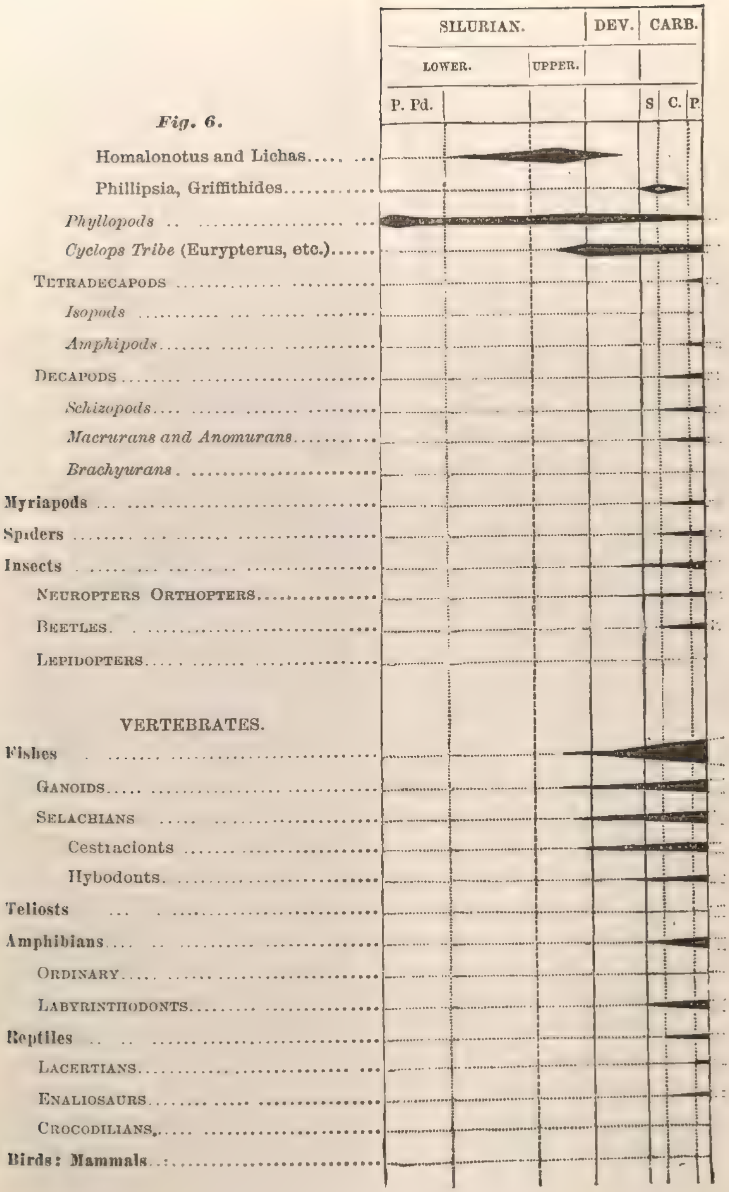
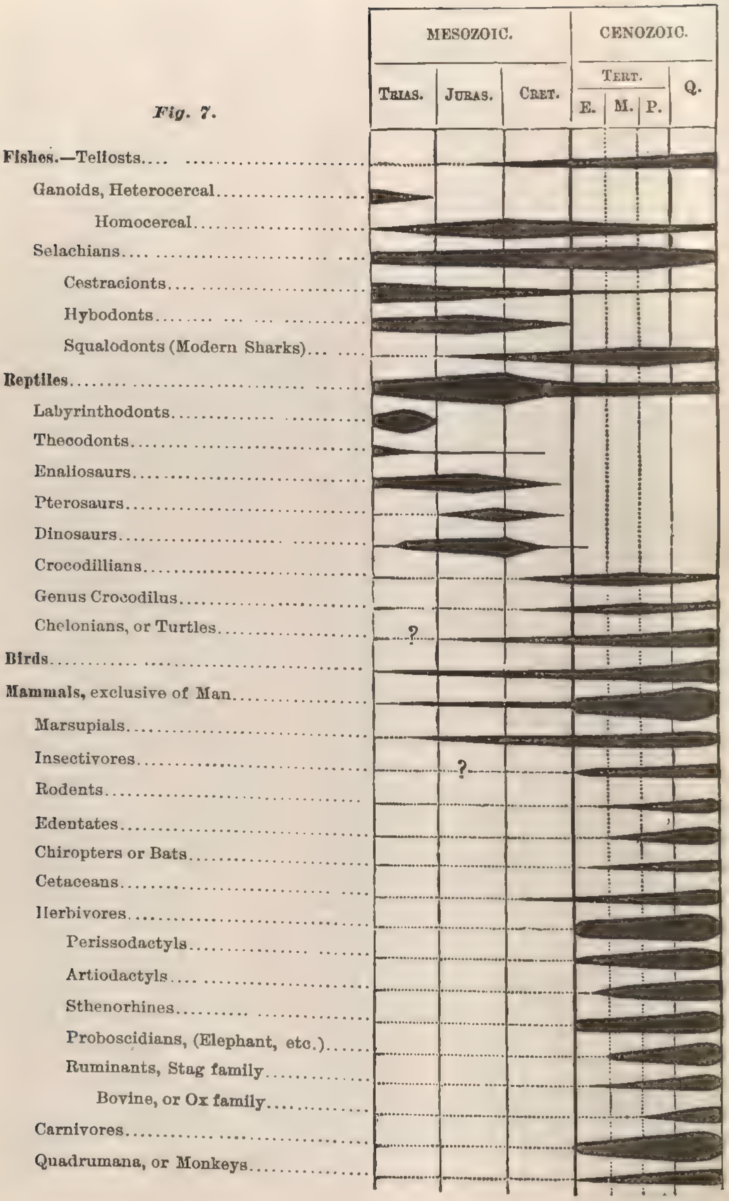

SILURIAN.
DEV.
CARB.
LOWER.
UPPER.
P. Pd.
S
C.
P.
Homalonotus and Lichas
Phillipsia, Griffithides
Phyllopods
Cyclops Tribe (Eurypterus, etc.)
TETRADECAPODS
Isopods
Amphipods
DECAPODS
Schizopods
Macrurans and Anomurans
Brachyurans
Myriapods
Spiders
Insects
NEUROPTERS ORTHOPTERS
BEETLES
LEPIDOPTERS
VERTEBRATES.
Fishes
GANOIDS
SELACHIANS
Cestracionts
Hybodonts
Teliosts
Amphibians
ORDINARY
LABYRINTHODONTS
Reptiles
LACERTIANS
ENALIOSAURS
CROCODILIANS
Birds: Mammals

Fig. 7.


MESOZOIC.
CENOZOIC.
TRIAS.
JURAS.
CRET.
TERT.
E.
M.
P.
Q.
Fishes.—Teliosts
Ganoids, Heterocercal
Homocercal
Selachians
Cestracionts
Hybodonts
Squalodonts (Modern Sharks)
Reptiles
Labyrinthodonts
Thecodonts
Enaliosaurs
Pterosaurs
Dinosaurs
Crocodillians
Genus Crocodilus
Chelonians, or Turtles
?
Birds
Mammals, exclusive of Man
Marsupials
Insectivores
?
Rodents
Edentates
Chiropters or Bats
Cetaceans
Herbivores
Perissodactyls
Artiodactyls
Sthenorhines
Proboscidians, (Elephant, etc.)
Ruminants, Stag family
Bovine, or Ox family
Carnivores
Quadrumana, or Monkeys

DESCRIPTIVE LIST

OF THE

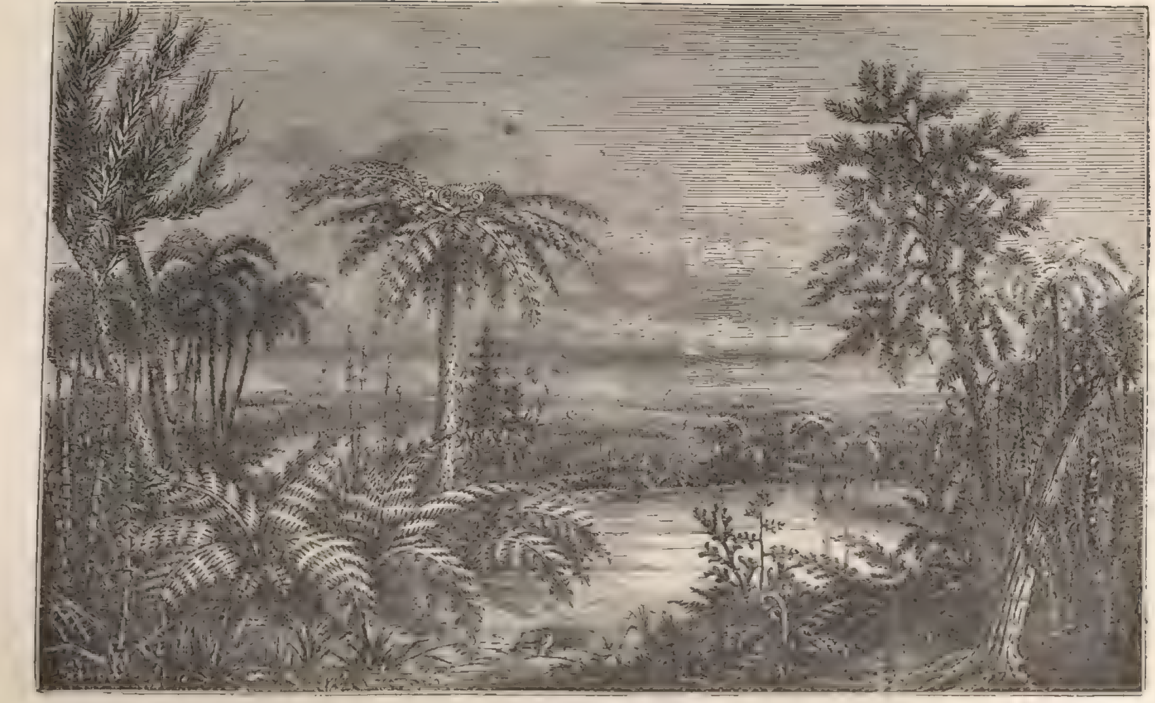
Principal Groups of Fossils in the Collection,

AND WHERE TO FIND THEM IN THE CASES.

PLANT REMAINS.

Plants are usually found fossil in detached fragments, and are generally known only by the remains of individual leaves or fragments of wood. Especially is this the case with our common forest vegetation, as the leaves are blown into streams and carried to the ocean, or into lakes, where they become buried in the sediment and preserved. Fragments of trunks or limbs of trees are preserved in the same manner. Petrified forests are only formed where a wooded region is suddenly submerged by waters heavily charged with mineral matter, caused by some volcanic action. Two beautiful sections of mineralized wood of this nature are placed upon the mineral case No. 5. The vegetation of the Coal period is often found in a very perfect condition of preservation, owing to the peculiar conditions under which it lived and became imbedded; nearly entire trunks are often found, and many times in an erect position. The accompanying cut of an ideal coal forest (taken from *Dana's Manual of Geology*) will give a good idea of these conditions, and the restored figures (after Dawson) show the form of the trees of the period to which they belong.

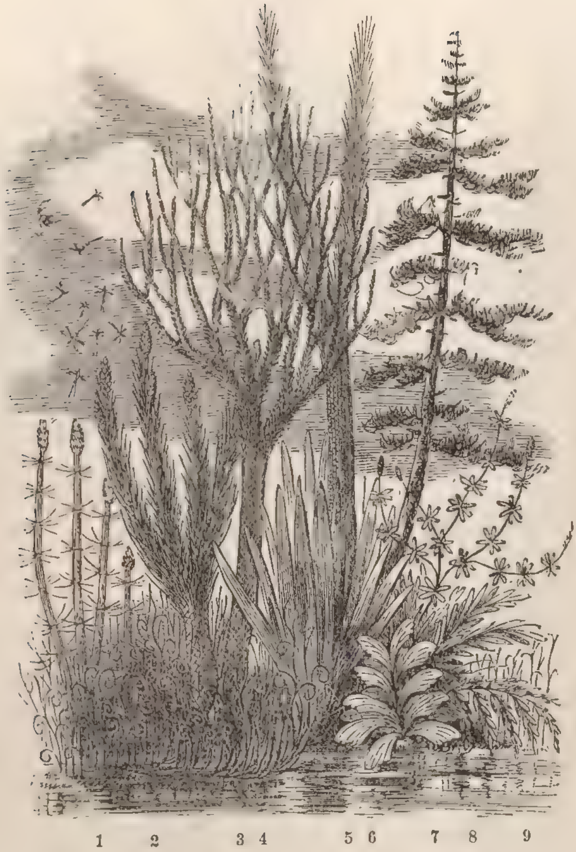
FIG. 8.



Carboniferous vegetation.

Ideal landscape showing the vegetation of the Coal Period with probable conditions. 1, Calamites; 2, Lepidodendron; 3, Tree-fern; 4, Araucarian Pine; 5, Sigillaria.

FIG. 9.



Restored vegetation of the Devonian Period, after Dawson. 1, Calamites; 2, Psilophyton; 3, Lepidophloios; 4, Lepidodendron; 5, Cordaites; 6, Sigillaria; 7, Cyclopteris; 8, Prototaxites (tree); 9, Asterophyllites.

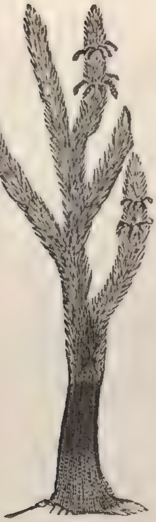


FIG. 10.—Sigillaria.

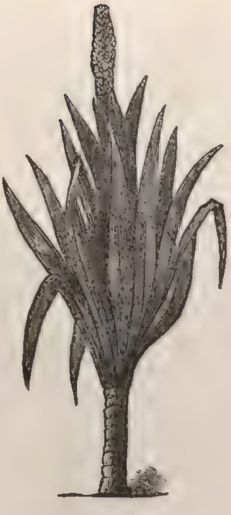


FIG. 11.—Cordaites.

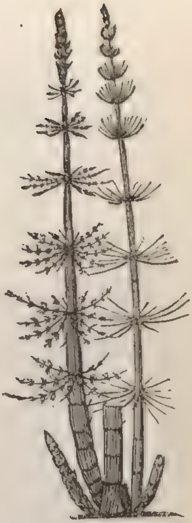


FIG. 12.—Calamites.

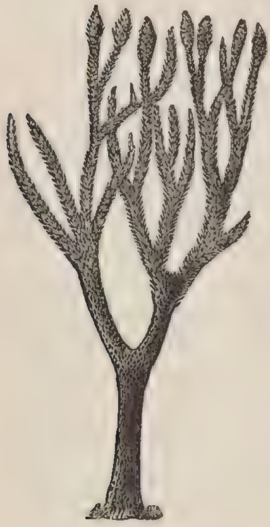


FIG. 13.—Lepidodendron.

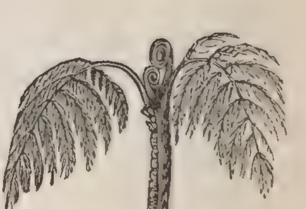


FIG. 14.—Tree-fern, Megaphyton.

Sea weeds are often preserved in the rocks, and examples of them are represented under most of the epochs from the Trenton to the Catskill inclusive; the most attractive forms being under the Medina and Clinton epochs, Case D, Sects. 11 and 12. Land plants are represented under the Oriskany epoch by the genus *Psilophyton*, a form of Lycopod (club-moss), and under the Hamilton epoch, by *Psilophyton*, *Sigillaria* and *Lepidodendron*, other forms of Lycopods. See Case H, Sect. 13, and Alcove Case 6. A few of these are found in the Chemung, and many very fine specimens of large size among the fossils of the Coal period, in Case N. *Ferns* are also represented under the Hamilton and Chemung epochs; but are largely represented under the Coal period, in Case O. A special collection of Devonian plants, from North America, of great value, is arranged in the Alcove Case, No. 6. Under the Cretaceous, Case P and Alcove Case, No. 13, a few leaves of deciduous trees may be seen from the red sandstones of Western Minnesota and elsewhere, among which are *Willow*, *Poplar*, *Laurel* and *Dogwood*. Under the Eocene there is a fine type series of fossil fruit from Brandon, Vt., Case P, Sect. 7 In the European series, Alcove Case, No. 16, there is shown a fine series of leaves of deciduous trees from the Miocene deposits of Switzerland.

ANIMAL REMAINS.

PROTOZOA.

FORAMINIFERA.

This group of animal remains are mostly of small size, generally minute; still they often form heavy beds of rock, many feet in thickness, as at Spergen Hill, Ind., where a bed, fifteen or more feet in thickness, is composed in great part of a minute form, represented in Alcove Case, No. 12, under the name *Endothyra Baileyi*. During the early geological periods some large forms occur which may be found represented under the name *Receptaculites* in the Western Trenton and Galena epochs, Case C and Alcove Case, No. 2; and a collection of enlarged models of living and fossil forms of this group is on exhibition in Alcove

Case, No. 15. The shells are usually composed of a number of chambers, the outer of which envelope the inner, with perforations (*foramina*) in the partitions. *Orbitoides* in the Eocene, Alcove Case, No. 14, *Dana's Manual* series, and *Fusulina*, in the Coal Measures, Case O, Sect. 6, are large examples. The following cut illustrates several of the known forms enlarged.

FIG. 15.

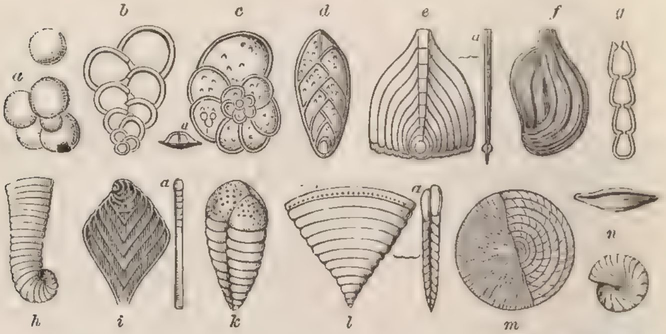


FIG. 15: *a*, Globigerina rubra; *b*, Textularia globulosa; *c*, Rotalia globulosa; *d*, Grammostomum phyllodes; *e*, Frondicularia annularis; *f*, Triloculina Josephina; *g*, Nodosaria vulgaris; *h*, Lituola nautiloides; *i*, Flabellina rugosa; *k*, Chrysalidina gradata; *l*, Cuneolina pavonia; *m*, Nummulites nummularia; *n*, Fusulina cylindrica. All enlarged, except Fig. *m*, and upper one of *n*.

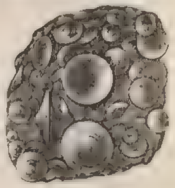


FIG. 16.
Orbitulina Texana, Nat. Size.

SPONGES.

Sponges are found as fossils in many of the geological formations, but most of them are very obscure in their characters and difficult to recognize. As examples of this form of animal life *Eozoon Canadensis* and the genus *Stromatopora* may be mentioned; these being probably sponges, although not always classed as such. See Alcove Case, No. 1 (*Dana's Manual* series), also Cases B, E, H and K. Other forms, as *Astylospongia* and *Astræospongia*, are represented in Cases E and F. There are also some very remarkable forms represented under the name *Dictyophyton*, first announced as sponges from this Museum; they resemble and are closely allied to *Euplectella*, the Venus basket, or glass sponge of the present seas. They can be seen in Alcove Case, No. 9, and in Case M, Sects. 6 and 13. In the European series, Case R, several other forms of fossil sponges may be seen.

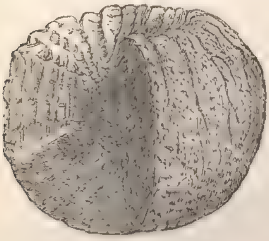


FIG. 17.—Astylospongia præmorsa

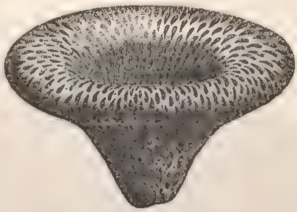


FIG. 18.—Scyphia reticulata.

CŒLENTERATA.

This sub-kingdom embraces a portion only of the animal forms formerly included under the old term RADIATA; namely, the corals and coral-like animals; and are divided into two groups or *Classes*, HYDROIDA and ZOANTHARIA. Some authors of note also include *Sponges*, while others again class them with the Protozoans.

HYDROIDA.

This group of animals are all aquatic; marine and fresh-water forms exist. They are mostly compound in their structure and increase by division or budding, and do not have the walls of the digestive sack separated from those of the general cavity of the body. Many of the jelly-fishes of our seas, the sea blubbers and sertularians or squirrel-tails of our beaches, and sea fans, belong to this class. They are represented among fossils principally by the *Graptolites* (stone-writings) in the lower and middle Palæozoic formations. *Stromatoporas* are also by some classed with them. The *Graptolites* may be seen in the Quebec group, Case B, Sect. 7 and 8, and in the Utica slate, Case D, Sects. 1 and 2; in the Clinton group, Case D, Sect. 12; Niagara group, Case E, Sect. 3, under the name *Dictyonema*; and also in the Potsdam (*Dana's Manual* series), Trenton, Upper Helderberg and Hamilton groups in single individuals. The general form of Graptolites may be understood from the following cuts, Fig. 19.

FIG. 19.

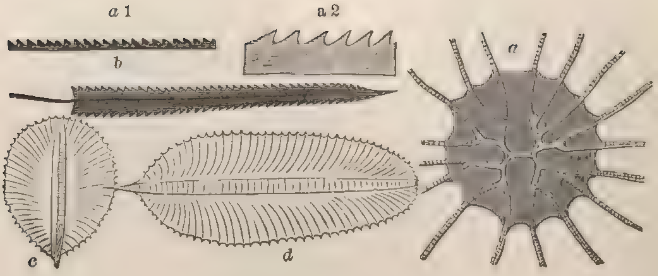


FIG. 19: *a*, Central disk and base of Graptolithus Logani ; *a* 1. Fragment of a stipe, natural size, and *a* 2, enlarged ; *b*, Diplograptus pristis ; *c* and *d*, Phyllograptus typus.

ZOANTHARIA.

This group embraces the true or polyp corals, the higher forms of jelly-fishes, *Ctenophora*, and sea anemones. Coral, as seen in collections, represents only the skeletons of the animals which form it. During life it is covered by a thin coating of gelatinous or fleshy substance, which constitutes the animal and contains or composes the organs which secrete the coral substance, as the true bony skeleton of the higher animals is secreted ; not being formed by insects, as usually stated. In compound corals each tube, cell or center of radiation forms the base of a separate individual or center of individual functions; while all are connected by the general envelope of the colony. The larger single corals, having only a single cell, or center of radiation, are single or independent individuals. During life the fleshy covering and organs are often of the brightest colors ; which, with their symmetrical form, cause them to resemble flowers of the most beautiful patterns. The following figures represent different types of corals, all of which may be found in the collection.

Fig. 20.—*ZOANTHARIA TABULATA.* (*Favosites.*)

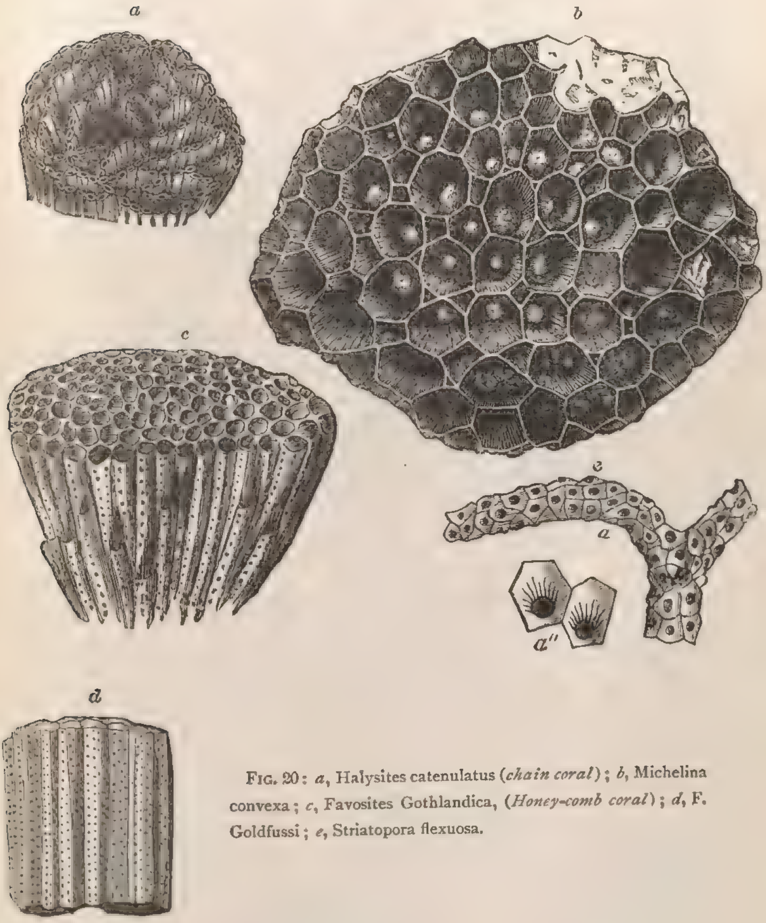


Fig. 20: *a*, Halysites catenulatus (*chain coral*); *b*, Michelina convexa; *c*, Favosites Gothlandica, (*Honey-comb coral*); *d*, F. Goldfussi; *e*, Striatopora flexuosa.

The **Favosites,** or honey-comb corals, will be found in Case C, Sect. 8, and in Case F, Sect. 1, Cases G and H, and in Alcove Case, No. 7; also in Case I, Sect. 1. The beautiful *Chain*-coral (Fig. 20, *a*) belongs to this group; fine examples of it may be seen in Case F, Sect. 1, and Alcove Case, No. 4.

Fig. 21.—*ZOANTHARIA RUGOSA.* (*Cyathophylloids.*)

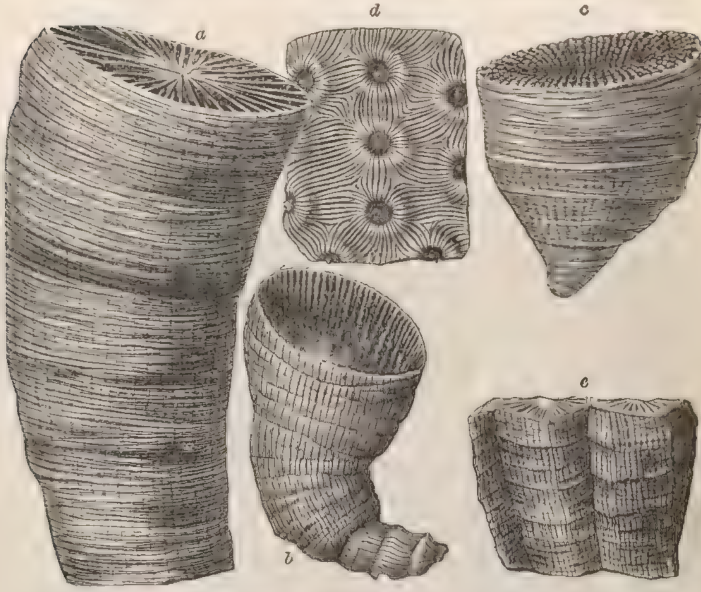


Fig. 21: *a*, Zaphrentis gigantea; *b*, Z. Rafinesquii; *c*, Heliophyllum Halli; *d*, Phillipsastrea Verneuili; *e*, Cyathophyllum rugosum.

The **Cyathophylloid** corals, or cup-corals, may be found under nearly all the epochs above the Chazy, being most abundantly represented under the Upper Helderberg, in Cases G, Sect. 10, and H, Sect. 1; under the Hamilton, Case I, Sects. 1 and 2, and in the Burlington and Keokuk limestones, Case M, Sects. 11 and 13.

Fig. 22.—*ZOANTHARIA ASTEROIDA Star Corals.*)

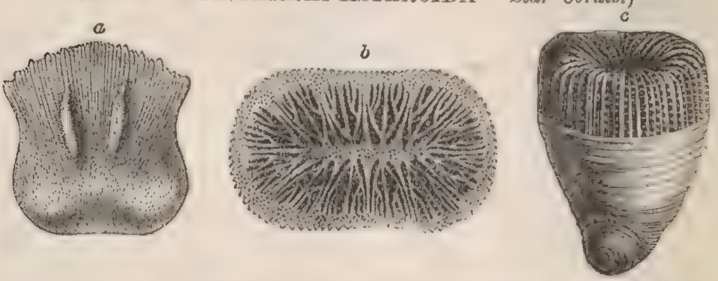


Fig. 22: *a* and *b*, Endopachys Maclurii, the last an enlarged top view; *c*, Montivaltia caryophyllata.

FIG. 22.—*Continued.*

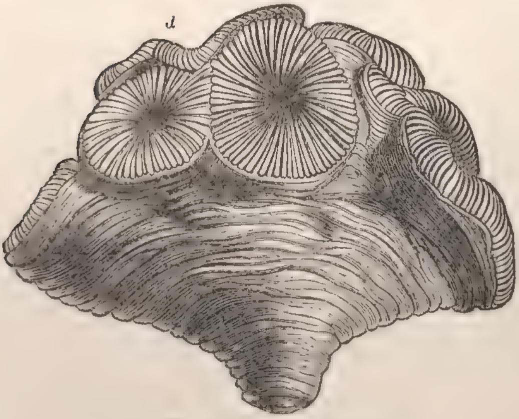


FIG. 22: *d*, Thecosmilia annularis.

A few of the **Asteroid** corals may be found under the Cretaceous, Case P, Sect. 1; and *Endopachys Maclurii* and allied forms in the Eocene, Case P, Sect. 10. Other forms may be seen in the European series, under the Jurassic.

SUB-KINGDOM ECHINODERMATA.

This group embraces the sea-urchins, star fishes and stone lilies, and is divided into the following five classes: CYSTOIDEA, CRINOIDEA, BLASTOIDEA, ASTEROIDEA and ECHINOIDEA. The organisms are composed of many separate pieces or plates, and the divisions into groups are made upon the form and arrangement of these plates and the habits of the animals, which are all marine.

CYSTOIDEA (*Sack-like*).

These bodies are sack-like in general form, and are destitute of a true radial structure in the arrangement of their plates. The arms are usually sessile, small in size or obsolete, and the body either sessile or supported on a short stem. They are much less numerous, and less attractive in form, than the *Crinoidea*. Examples may be found under the Trenton group, in the Alcove Case, No. 1; in the Hudson River group (*Agelacrinus*), Alcove Case, No. 2; in the Niagara group, Alcove Cases, Nos. 3 and 4; and under the Lower Helderberg group, Case F, Sect. 10. *Caryo-*

crinus is placed in this group by some of the later writers, but it has nearer relations with the true *Crinoidea.*

Fig. 23.—*CYSTOIDS.*

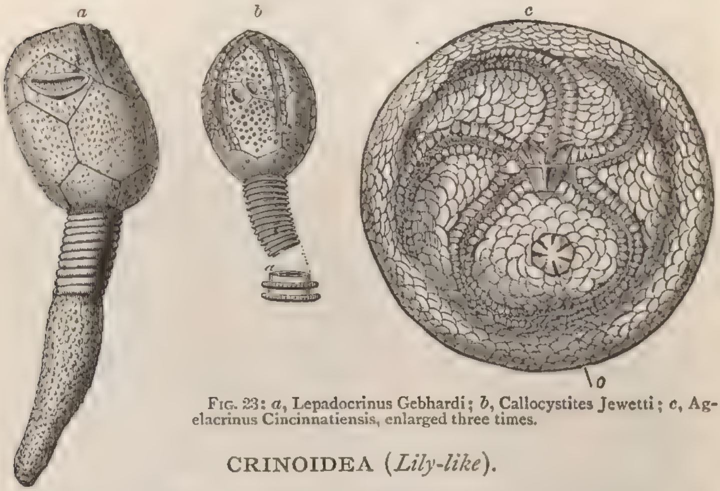


Fig. 23: *a*, Lepadocrinus Gebhardi; *b*, Callocystites Jewetti; *c*, Agelacrinus Cincinnatiensis, enlarged three times.

CRINOIDEA (*Lily-like*).

This group, the *Stone-lilies*, embraces the most beautiful and attractive forms of organic remains known. They are sack-like bodies, made up of separate plates arranged in rays from the base of the body, and are surmounted by a series of arms and fingers, also composed of a large number of pieces. The whole is supported on a stem, composed of plates of greater or less length, and was rooted to the bottom of the ocean, or to other substances, like a plant. From this, and the similarity of the body and arms to parts of a flower, they have been called *Stone-lilies.* Although rooted and fixed and so plant-like in appearance, they were true animals and had animal functions. The cavity of the body contains a calcareous convolute plate, which is supposed to have supported the stomach or digestive organ and is frequently found preserved in the fossil forms. Crinoids were extremely abundant in the Palæozoic seas, and vast beds of limestone are made up principally of their remains. Their remains are found from the earliest period of fossils (Potsdam) to the present, when but few forms are known, one of which is represented in Case N, Sect. 6. As fossils they are usually found only in a fragmentary condition, as, in consequence of being made up of a large number of pieces, held together only by a thin film of animal matter, they rapidly fall apart after death. The following figures are given as examples of Crinoids.

FIG. 24.—*CRINOIDS.*

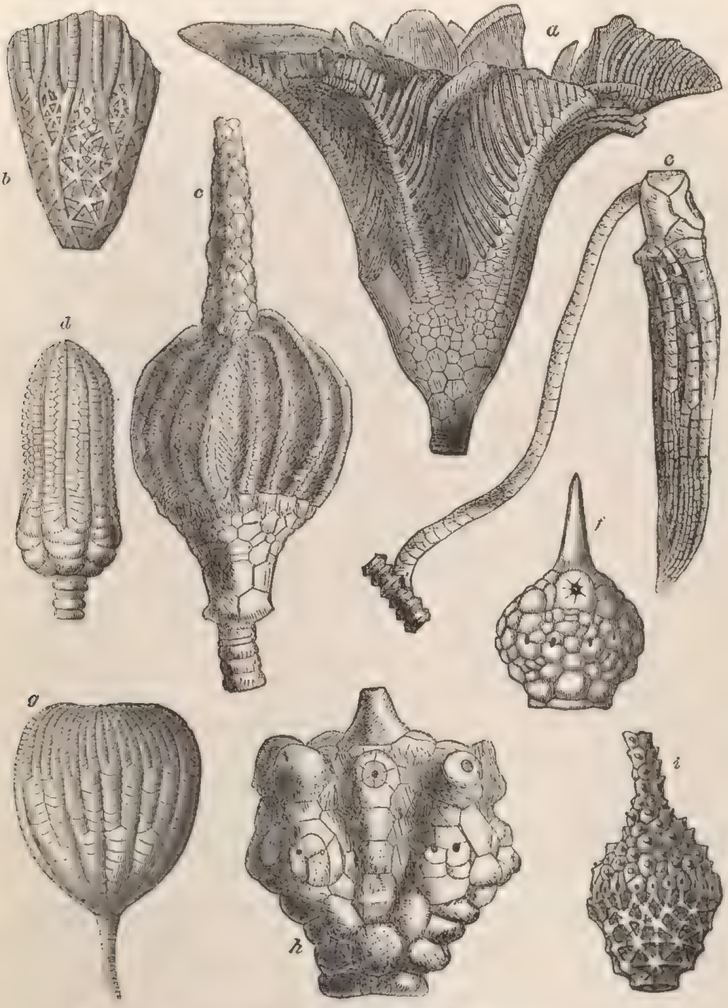


FIG. 24: *a*, Mariacrinus nobilissimus; *b*, Glyptocrinus decadactylus; *c*, Batocrinus pyri formis; *d*, Encrinus liliiformis; *e*, Calceocrinus clarus; *f*, Dorycrinus unicornis; *g*, Ichthyocrinus lævis; *h*, Dorycrinus quinquelobus; *i*, Actinocrinus proboscidialis.

Examples of Crinoids may be found under the Trenton formation, in Alcove Case, No. 1, and in Case C, Sect. 1; under the Hudson River group, in Alcove Case, No. 2; Niagara, in Alcove Case No. 3; a very fine series, perhaps the best in existence, from a New York locality, Lockport. Also from Waldron, Ind., in the same formation, a remarkably good series of illustrated examples, especially of Eucalyptocrinus, in Case E, Sect. 11. Among these are many of the roots of specimens of this genus showing the rootlets spreading in the shale like those of a plant. In Alcove Case, No. 4, are many internal casts of Crinoids, and in the Lower Helderberg formation, Case F, Sect. 10, are some very fine specimens; see also Case H, Sect. 8; Case I, Sect. 2, and Alcove Case, No. 9. Among the Crinoids of the Lower Carboniferous, special attention may be directed to those of the Burlington and Keokuk limestones, Case M, Sects. 11 and 13; Alcove Case, No. 11, both sides, and Case N, Sect. 1. In this latter case there is preserved in alcohol an example of a species now living on the coast of Barbadoes, West Indies. Case N, Sect. 10, contains many forms from the Chester limestone; and in Case R, Sects. 4 and 6, will be found a very fine slab of the *Pentacrinus briareus*, from the Liassic rocks, of Lyme Regis, England, and one of *P. subangularis* from the same formation at Holzmünden, Germany.

BLASTOIDEA (*Bud-like*).

These fossils, usually called *Pentremites*, on account of their pentangular or pentalobate form, are generally small, and are known by the vulgar names "petrified hickory-nuts," or walnuts. They are very beautiful objects and somewhat resemble flower buds, hence the order name *Blastoidea*. The fossil, as it is usually seen, is only the body portion, which in life was supported on a slender stem, rooted to the bottom of the sea, or to foreign objects, like the true *Crinoids;* while instead of arms the ambulacra, or transversely grooved areas, were covered by very slender, thread-like tentaculæ, which probably served the same purposes as did the Crinoid's arms. The following illustrations will give an idea of their forms.

FIG. 25.—*BLASTOIDS.*

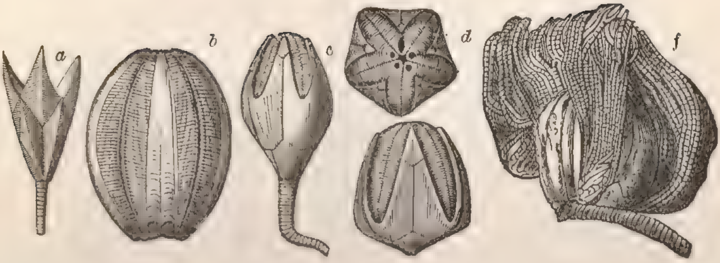


FIG. 25: *a*, Stephanocrinus angulatus; *b*, Nucleocrinus Verneuili; *c*, Pentremites pyriformis with stem; *d* and *e*, top and side views of P. Godoni; *f*, Granatocrinus Norwoodi, with column and tentaculæ preserved.

Examples of these forms may be found under the New York Niagara, in Alcove Case, No. 3 (*Stephanocrinus*); Case F, Sect. 7; in the Upper Helderberg group, Case H, Sect. 8; in the Burlington division of the Lower Carboniferous, Case M, Sect. 12, and in the Chester division, Case N, Sect. 10.

ASTEROIDEA (*Star-like*).

This group contains the true star-fishes, both fossils and living. They are not very common as fossils in the rocks of the Palæozoic ages, but are sparsely represented in several of them. In the Trenton group, Alcove Case, No. 1, a single imperfect individual of *Palæaster* may be seen, and a very fine example in the Alcove Case, No. 2, under the Hudson River group. In the Lower Helderberg group, Case F, Sect 10, under the name *Protaster Forbesi* some examples of a very pretty little form may be seen. In the Hamilton group, Case I, Sect. 2, other *Palæasters* are exhibited, and other very fine forms from the Keokuk limestone in Case N, Sect. 1, under the name *Onychaster.*

Fig. 26.—*ASTEROIDS.*

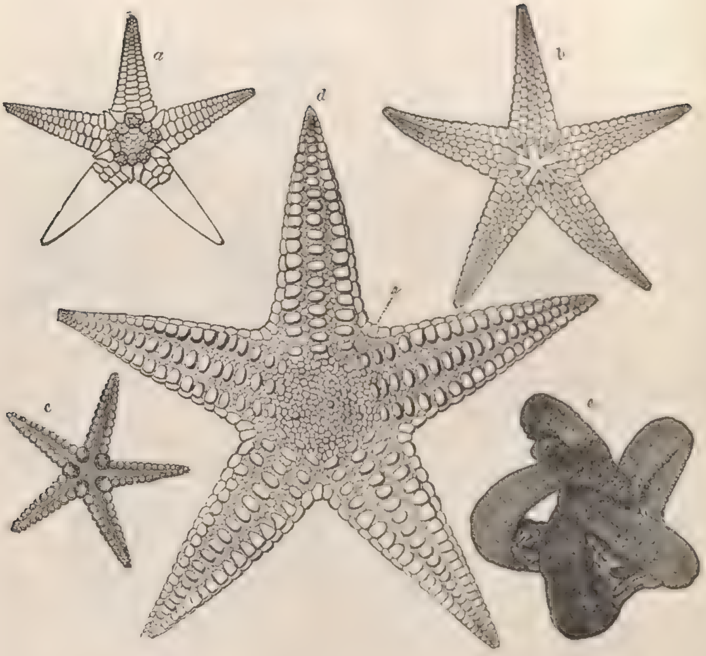


Fig. 26; *a*, Palæaster matutina; *b*, P. Shæfferi; *c*, P. Niagarensis; *d*, P. Eucharis; *e*, Onychaster flexilis, the rays folded.

ECHINOIDEA.

This, the highest type of the *Echinodermata* (spiny skins), contains the true *Sea urchins*, or *Sea-eggs*, as they are often called. They consist of spheroidal, hollow bodies, usually covered with spines, whence their name, from Echinus, *Hedge-hog*, in allusion to the spines. They are composed of distinct plates, arranged in regular geometrical order, often highly ornamented, and are always marked by five perforated areas, which radiate from one of the central openings, and which represent the rays of the star-fish, the arms of the Crinoid, or striated areas of the Blastoid. True Echinoids do not appear until the Hamilton period, and are not abundant until the Mesozoic age.

FIG. 27.—*ECHINOIDS.*

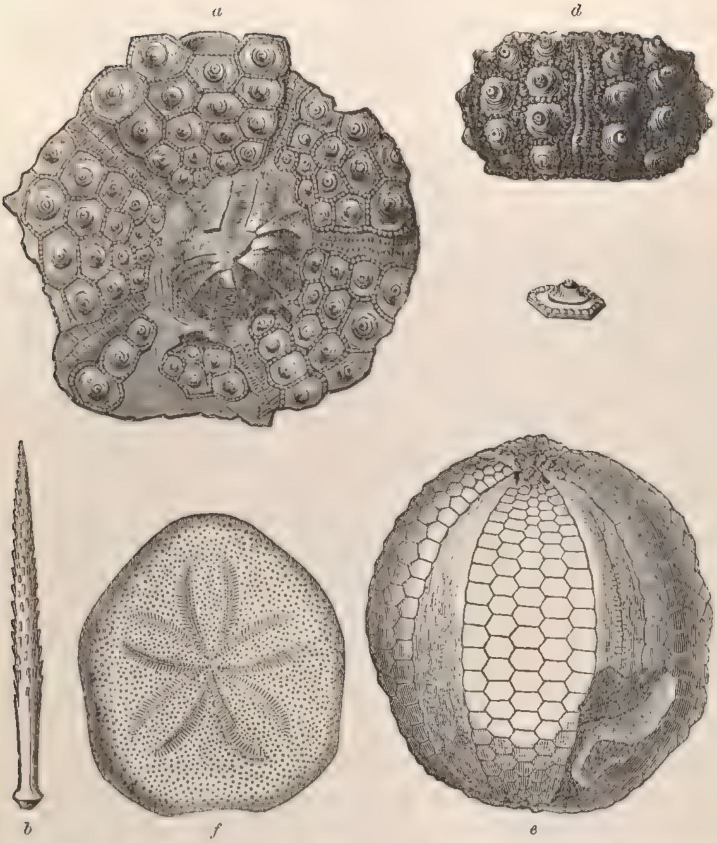


FIG. 27: *a*, Archæocidaris Wortheni, flattened; *b*, Spine of A. Shumardi; *c*, Plate of same; *d*, Cidaris Blumenbachi; *e*, Melonites (Oligoporus) nobilis; *f*, Mortonia Rogersi.

A single form only is known in the Hamilton group, represented in Case I, Sect. 2, by a plaster cast. In the Waverly group, Case M, Sect. 6, *Lepidechinus* is represented by two specimens. In the divisions of the Lower Carboniferous *Archæocidaris* is represented by spines and a few plates, and in Case N, Sect. 7 (bottom), by some very fine examples. *Melonites* is also represented in this section, by two very fine slabs, and in the Alcove Case, No. 12

(*Dana's Manual* series), by a very fine individual. In the Cretaceous of New Jersey, Case P, Sect. I, and in the Tertiary, there are very many fine representatives of several genera; also in the European case, under the same formation.

SUB-KINGDOM MOLLUSCA.

SECTION MOLLUSCOIDEA.

The Molluscoids are represented among fossils by two classes, *Brachiopoda* and *Bryozoa.* The former are shell-bearing, while the latter are compound animals of various forms, but secreting a calcareous or horny base which supports the colony.

BRYOZOA (*Moss animals*).

These objects are rather inconspicuous as fossils, to the naked eye, but under a magnifying glass show features of remarkable beauty. They are also compound in structure, forming colonies the basis of which are the structures obtained as fossils. They are largely parasitic and incrusting, forming thin films of a net-like structure on other fossil bodies. Some form expanded frond-like structures of a calcareous net work, filled with pores, each of which was the home of a separate individual of the colony. Others again form branching structures, resembling coral, and have usually been considered as such; the surface being covered with the minute pores, often arranged in patterns and rising into tubercles. The cuts on the following page will afford some idea of some of their forms.

Fig. 28.—*BRYOZOA.*

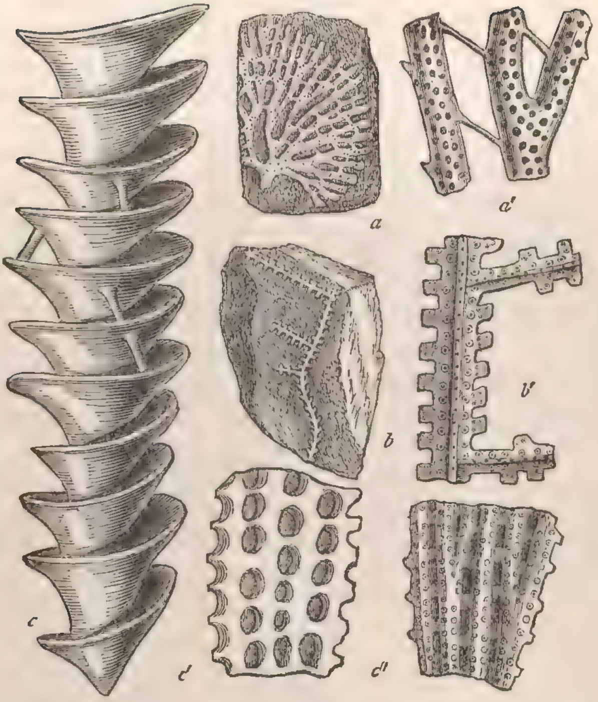


Fig. 28: *a*, Polypora dendroides; *a'*, an enlargement of a portion showing the pores; *b*, *b'*, Glauconome pulcherrima, natural size and enlarged; *c*, Archimedes Wortheni, central axis; *c'* and *c*,'' enlarged fragments of portions of the frond, which grows from the edge of the screw, forming a broad expansion.

The fossils of this class may be found in nearly every epoch, to a greater or less extent. They are represented in the collection under the Chazy and Black River groups only sparingly. In the Trenton are some peculiar forms under the generic name *Escharopora*, in Case C, Sect. 1, and others in Sect. 8. Under the Hudson River group, in Case D, Sect. 4, there are many forms, especially of the Genera *Chætetes* and *Monticulipora* and allied forms. Under the Clinton group, Case D, Sect. 13, will be found forms of *Fenestella*, *Retepora*, &c., and under the Niagara, in Case E, Sects. 4, 5, 11 and 12, there are many forms not represented in the lower rocks. In Case F, Sect. 10, and Case H, Sects. 2 and 10, and Case I, Sect. 3, will be found other forms and other genera. In the Chemung and Waverly only a few obscure forms are represented; but in the Keokuk and Chester divisions of the Lower Carboniferous rocks, many forms of peculiar interest are exhibited, especially *Archimedes;* see Case N, Sects. 1 3, 6, 7 and 10. There are also a few shown under the New Jersey Cretaceous.

BRACHIOPODA.

The **Brachiopoda** are mostly small, shell-bearing, marine animals, which derive their class name, which means *arm-footed*, from the form of their breathing organs, which are often coiled in form of a spiral, and are in some cases long and slightly flexible, so as to be protruded beyond the shell, like arms or feet. They are the most abundant fossils in the Palæozoic rocks in America and in the European Mesozoics, and may be found represented under all the groups. They are the lamp shells of the ancients, and may usually be distinguished from the other bivalve shells by their form, being bilaterally symmetrical from a vertical line extending from the apex to the base, while one valve is usually much larger and longer than the other. The following illustrations will convey an idea of their general form.

FIG. 29.—*BRACHIOPODS.*

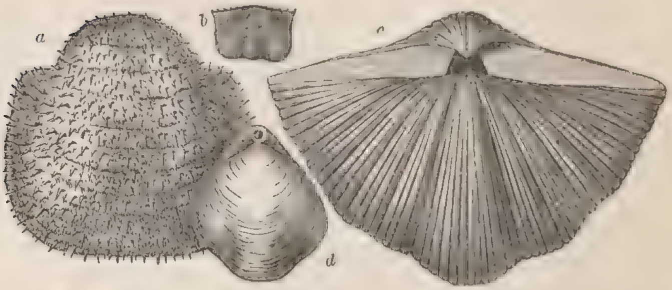


FIG. 29: *a*, Productus Nebrascensis; *b*, Chonetes mesoloba; *c*, Spirifera camerata; *d*, Athyris subtilita.

FIG. 29.—*Continued.*

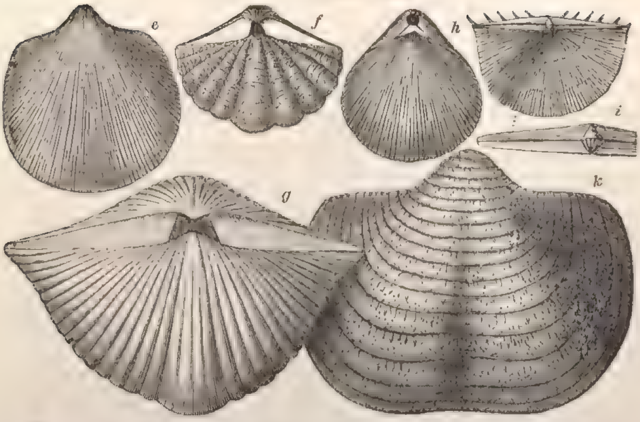


FIG. 29: *e*, Orthis Michelina; *f*, Spiriferina spinosa; *g*, Spirifera bisulcata; *h*, Eumetria Verneuiliana; *i*, Chonetes variolata and enlargement of hinge; *k*, Productus vittatus.

FIG. 30.—*BRACHIOPODA.*

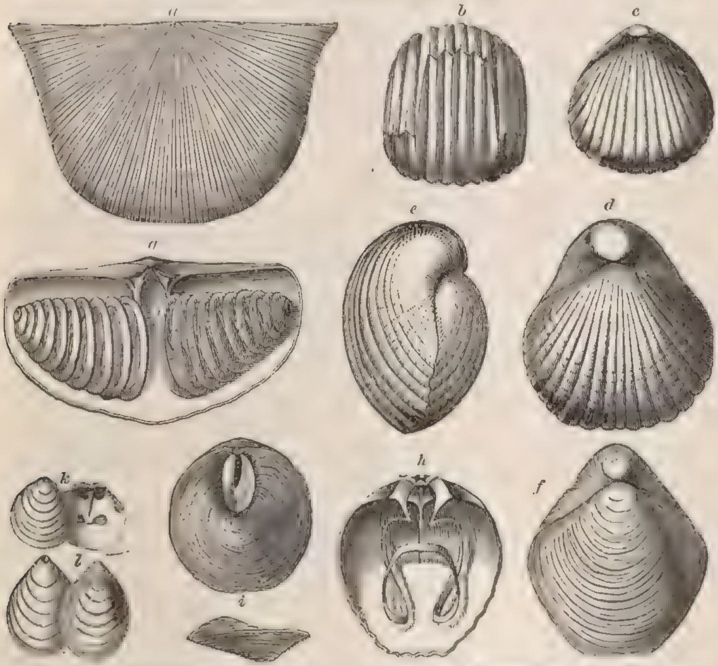


FIG. 30: *a*, Streptorhynchus radiata; *b*, *c*, Rhynchonella pyramidata; *d*, *e*, Pentamerus galeatus; *f*, Meristella lævis; *g*, smaller valve of a Spirifer showing the internal spiral arms; *h*, smaller valve of Waldheimia flavescens, with the loop which supports the arms; *i*, Discina lamellosa, the lower figure being a side view; *k*, Obolella Apollinis; *l*, Siphonotreta unguiculata.

The Brachiopoda are not only more numerous as fossils than any other group of animal remains, but are the best guides in determining the position and age of the strata, from the earliest appearance of life to the close of the Carboniferous formations. From that period onward they become rapidly less numerous, especially in Genera, to the present time, when there are only about one hundred and twenty living species known.

MOLLUSCA.

The true Mollusca are the real shell-bearing animals, whether Marine, Fresh-water, or Land. This section of the sub-kingdom is divided into four principal classes : *Lamellibranchiata*, *Gasteropoda*, *Pteropoda* and *Cephalopoda* ; each of which is seperately considered below.

LAMELLIBRANCHIATA.

This class comprises the bivalve shells, such as *Oysters*, *Clams*, *Cockles*, *Scallops* and Fresh-water Mussels. They differ from the Brachiopods, which are also bivalve, in being symmetrical on the opposite sides of the line of junction of the valves, and in the valves being inequilateral of themselves ; while with the Brachiopods the reverse is the case. Shells of this group first make their appearance in the Cambrian (Potsdam), in America, where they are represented by two species only, one a nuculoid shell (*Fordella*), the other an undescribed genus. They gradually increase in number from that period to the present time, when they appear to have attained their maximum development. They are comparatively abundant in the Trenton, Hamilton and Chemung epochs, but not numerous in the other parts of the Palæozoic formations. The following illustrations will give an idea of their forms.

Fig. 31.—*LAMELLIBRANCHIATES.*

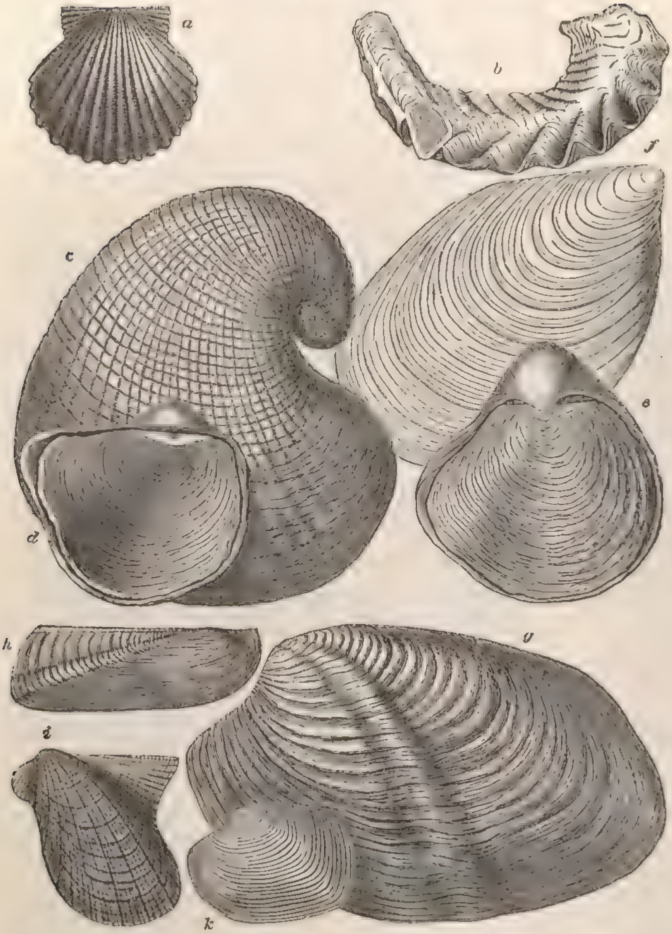


Fig. 31: *a*, Pecten Poulsoni; *b*, Ostrea larva; *c*, Exogyra costata; *d*, Gryphæa vesicularis; *e*, G. Pitcheri? ; *f*, Inoceramus problematicus; *g*, Grammysia bisulcata; *h*, Orthonota undulata; *i*, Pterinea flabella; *k*, Microdon bellastriata.

In the collection there are but few species represented below the Trenton, but there are many forms represented under that period; see Case C, Sects. 3 and 11. Under other epochs there are species represented in Case D, Sects. 8 and 10; Case E, Sect.

1; Case F, Sect. 8; Case G, Sects. 1 and 7; Case H, Sects. 4 and 11. In the Hamilton group they are very numerous; see Case I, Sects. 10 to 13, and Case J, Sects. 1 to 3. Alcove Case, No. 8, is partially devoted to figured specimens of this group. The Chemung group also affords large numbers of them; see Case L, Sects. 12 and 13; Case M, Sect. 1, and Alcove Case, No. 10. Among the Catskill rocks there is a single species represented, *Amnigenia Catskillensis*, Vanuxem, Case M, Sect. 3, which is probably of fresh-water origin, and if so, is the earliest representative of fresh-water Mollusca on the American continent. The Carboniferous epochs afford only a few species each, but in the Cretaceous and Tertiary they are extremely abundant, and in the latter are exceedingly like those of the present seas; see Case P, Sects. 8, 10 and 11.

GASTEROPODA.

This group comprises the modern SNAILS, or coiled and spiral shells, called univalve, as they consist of only one piece, although there is often a covering for the aperture. They are either Marine, Fresh-water or Land. They make their appearance in the Potsdam epoch, in the genera *Platyceras*, *Holopea* and *Ophileta*, and constantly increase in numbers to the present time; although in some of the epochs they were but sparingly represented over certain regions. The older forms were mostly of the sections HOLOSTOMATA and SCHIZOSTOMATA, and were to a great extent vegetable feeders. The SIPHONOSTOMATA, which are generally carnivorous, are not abundant until the Mesozoic time, although the genus *Fusispira*, in the Trenton epoch, presents the general features of shells of this group. The PULMONIFERA (air breathers or land snails), appear first, so far as at present known, in the Devonian epoch, and are most abundantly represented at the present time. Examples of two minute forms from the Coal epoch, *Pupa Vermilionensis* and *Dawsonella Meeki*, may be seen in the *Dana's Manual series* of that epoch.

The section HETEROPODA, including *Bellerophon*, *Bucania*, *Cyrtolites*, &c., is represented under the Trenton, Upper Helderberg, Hamilton, Chemung and Carboniferous. The following figures give a few forms of the GASTEROPODA.

Fig. 32.—*GASTEROPODS AND HETEROPODS.*

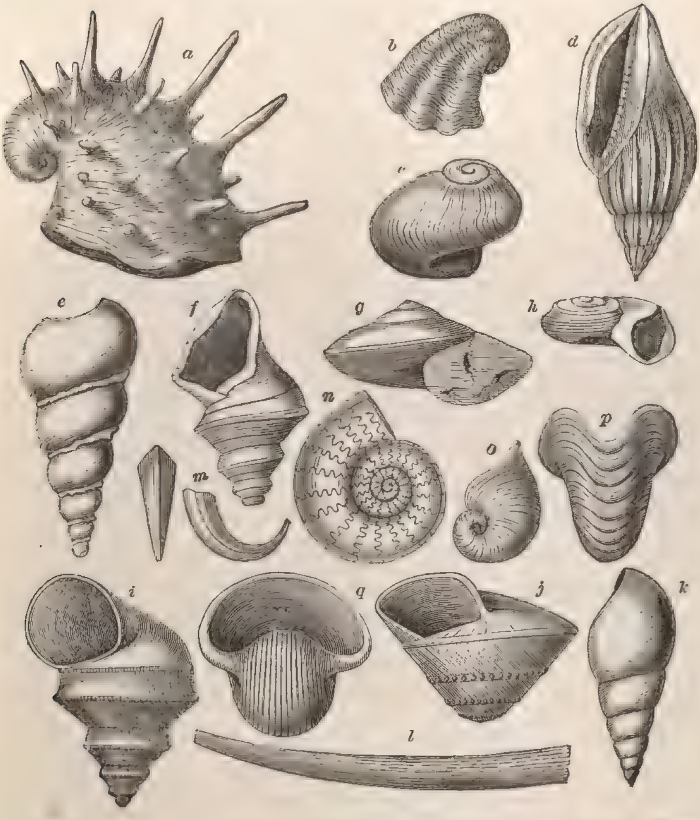


Fig. 32.—Gasteropods.—*a*, Platyceras dumosum; *b*, P. angulatum; *c*, Platyostoma Niagarensis; *d*, Cithara Mississippiensis; *e*, Murchisonia bellicincta; *f*, M. bicincta; *g*, Raphistoma lenticularis; *h*, Helicotoma planulata; *i*, Pleurotomaria tabulata; *j*, P. sphærulata; *k*, Macrocheilus fusiformis; *l*, Dentalium Mississippiense. Heteropods.—*m*, Ecculiomphalus Trentonensis; *n*, Cyrtolites compressus; *o* and *p*, Bellerophon bilobatus; *q*, B. carbonarius.

Examples of Gasteropoda may be found under nearly every epoch represented. The most noted ones are in the Chazy, Case B, Sect. 11; Trenton, Case C, Sects. 3, 4 and 11; New York and Western Niagara, Case E, Sect. 13. Some peculiar ones in the Guelph, Case F, Sect. 8; Lower Helderberg, Case G, Sect. 2; Oriskany, Case G, Sects. 7 and 8; Lower Helderberg, Case H, Sects. 4 and 6; Hamilton, Case J, Sects. 3 and 4. The Coal Measures afford a few only, but in the Cretaceous and Tertiary there are many, especially in the Eocene, from Claiborne, Ala., where they are nearly as perfect as recent shells; Case P, Sect. 12. The European collection affords a few scattered examples, but in the Paris basin, Eocene, Alcove Case, No. 16, are many fine ones.

PTEROPODA.

This group is composed entirely of open sea animals, the most of which are destitute of shells, and consequently are not found fossil. The shells, when present, are small, usually thin and fragile, and as fossils generally imperfect. They are represented as fossils by only a few genera; *Hyolithes*, *Tentaculites* and *Conularia* being the principal ones. *Tentaculites* are so abundant in the Lower Helderberg period, as to form layers of rock many feet in thickness, in Albany and Schoharie counties, in New York. The following figures represent specimens of two of these genera.

FIG. 33.—*PTEROPODS.*

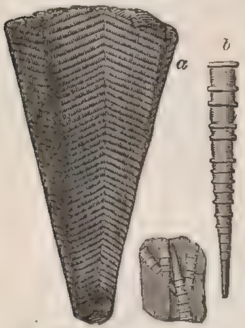


FIG. 33: *a*, Conularia Trentonensis; *b*, Tentaculites gyracanthus, natural size and enlarged.

Species of *Hyolithes* may be found under the Potsdam formation, Case B, Sects. 1 and 2. *Conularia* is represented in Case C, Sect. 4, and Case E, Sect. 7; Case G, Sects. 2 and 7; Case J, Sect. 4, and Case N, Sect. 4. *Tentaculites* may be found in Case G, Sect. 2, and Case J, Sect. 4.

CEPHALOPODA.

This, the highest group of Mollusca, is divided into two principal branches: TETRABRANCHIATES (four lunged) and DIBRANCHIATES (two lunged). The first is represented in the present seas by the genus *Nautilus*, and the last by the *Cuttle-fishes*, *Squids* and by the *Argonaut*. As fossils the first division is known from near the beginning of the Palæozoic series of the latest Tertiary, and the latter at least as far back as the Triassic. The first are recognized in the fossil state principally by their septate character, the shells being divided into sections by transverse partitions, similar to the recent Nautilus (see section of Nautilus in shell collection desk case, No. 15). Among the fossil forms may be found shells of nearly all shapes from the Orthoceras (straight horn) of the Palæozoic epochs, to the closely coiled Ammonite (Ammon's horns) of the Triassic and Cretaceous; and among them, some of the most attractive and interesting fossils known. In the Silurian epochs they are represented by *Orthoceras*, *Endoceras*, *Cyrtoceras*, *Nautilus*, and many other genera. In the Devonian, *Goniatites* is added, and in the Mesozoic epochs *Ammonites* and *Baculites* (staffs shells) are numerous. These latter forms, together with all their close allies, have the partitions lobed where they join the outside shell, and form complicated leaf-like patterns on the surface, where the shell is broken away; see *Baculites*, *Ammonites* and *Scaphites* in the Cretaceous, Case P, Sects. 4 and 6. Some of the earliest forms of Cephalopods may be found in Case B, Sect. 13, a form erroneously thought to represent the back-bones of fishes. Others may be found in Case C, 4, 6 and 12, and Alcove Case 2; also Case F, 4, and Alcove Case 4; Case G, 11 and 12; Case H, 6, 11 and 13; Alcove Case 9; also in Case M, Sect. 9, may be seen characteristic *Goniatites* with their angular septa. In the Coal Measures, Case O, Sect. 11, Cretaceous in Case P as above noted, and in the European series, Case R, Sects. 4, 6, 10 and 11.

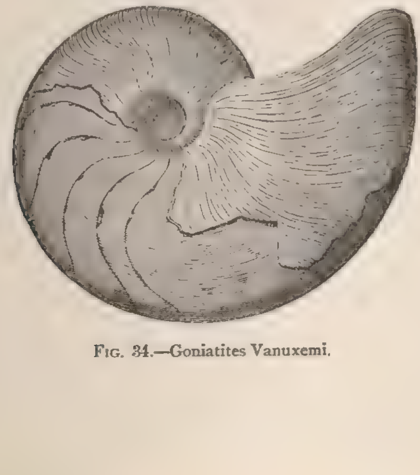


FIG. 34.—Goniatites Vanuxemi.

FIG. 35.—*CEPHALOPODS.*

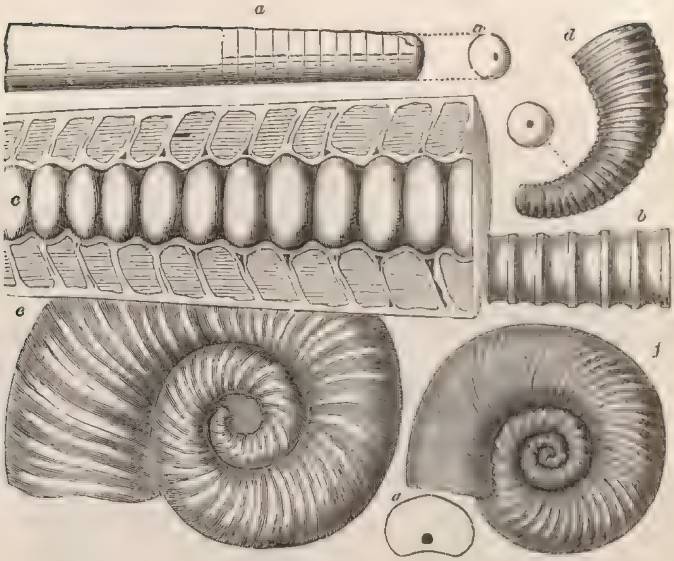


FIG. 35: *a*, Orthoceras junceum; *b*, O. vertebrale, reduced; *c*, Ormoceras tenuifilum, longitudinal section showing septa and siphon; *d*, Cyrtoceras annulatum; *e*, Lituites undatus; *f*, Trocholites ammonius.

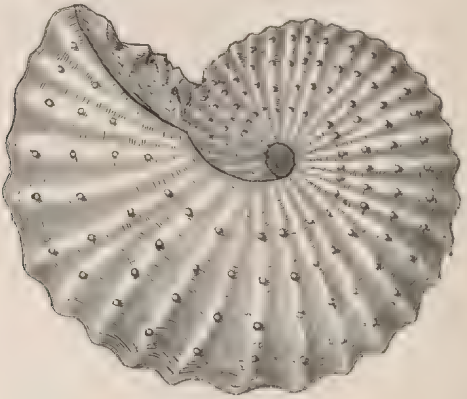


FIG. 36.—Scaphites Conradi.

SUB-KINGDOM

ARTICULATA OR ARTHROPODA.

CRUSTACEA.

TRILOBITA.

During the earlier Palæozoic epochs to near the close of the Silurian ages, Trilobites formed the highest grade of organized beings (*except perhaps the Cephalopoda*), and were frequently very abundant. They were the crabs and lobsters of those times; their nearest living representative being probably the king-crabs of our own coasts. Trilobites make their appearance among the very earliest forms of fossil remains, and continue to the Coal period; at the close of which time they became extinct. They were extremely abundant, and in fact formed the principal animal life during the earlier Primordial epochs, although in many places their remains are entirely fragmentary. The following illustrations will give an idea of some of their forms.

Fig. 37.—*TRILOBITES.*

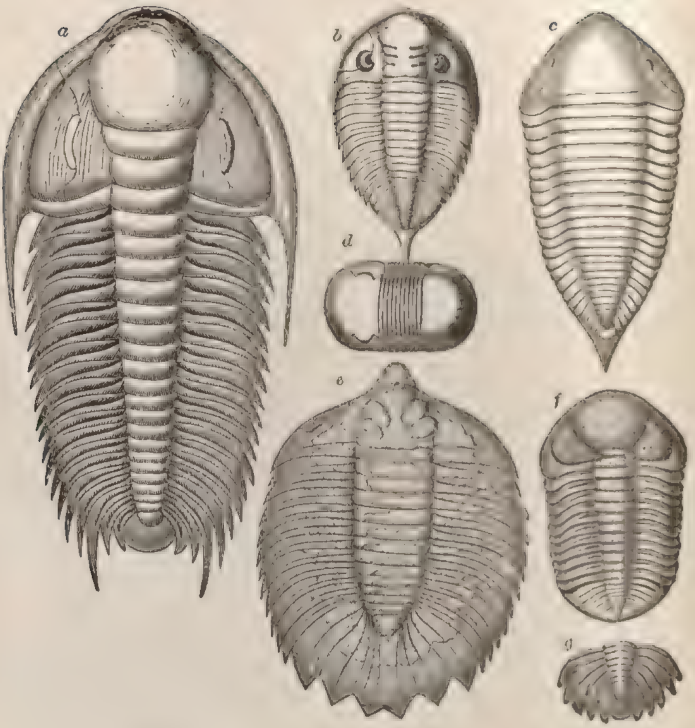


Fig. 37: *a*, Paradoxides Harlani; *b*, Dalmania limulurus; *c*, Homalonotus delphinocephalus; *d*, Illænus Ioxus; *e*, Lichas Bolonti; *f*, Phacops rana; *g*, tail of Dalmania Boothi.

Examples of Trilobites may be seen in Case B, Sects. 1, 3, 4 and 6; Case C, 6, 7 and 13, and Alcove Case 2; Case D, 10, and in Alcove Case 3, a few very fine specimens. In Case E, Sects. 8 and 10, and Alcove Case 4, is shown perhaps the finest known series of New York, Niagara Trilobites. Others may be found in Case F, 6; G, 3 and 12; H, 6, 7 and 11, and Alcove Case 9. There are a few individuals only in the higher formations; those of the Keokuk limestone, Case N, Sect. 4, being the most numerous. In the European series, Case R, Sect 1, there are also a few individuals.

MEROSTOMATA.

Another form of Crustacea less common than the Trilobites, but quite as remarkable, is that of the Eurypteroids (broad wings), a group not known until the Medina epoch. They appear to have flourished in highly salt waters, and must have been quite abundant in the seas which covered central and western New York during the deposition of the rocks of the Onondaga Salt group, under which epoch there is a large and beautiful collection of them exhibited. See Case F, Sect. 8, and in Alcove Case 5 ; perhaps the finest collection of type specimens of these fossils in existence. They also flourished in the Catskill period, but in this country are very scarce, only a single head of a very large species having been found ; while in Scotland they were numerous and of gigantic proportions; some of their fragments indicating a length of nearly twelve feet. They appear again in the Coal Measures in Pennsylvania and in Illinois ; a single individual from the latter state being on exhibition in Case O, Sect. 11.

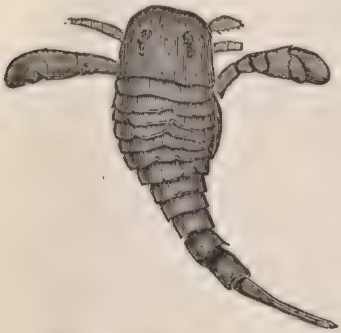


Fig. 38.—Eurypterus remipes.

There are a few other forms of articulates scattered through the collection, but none of great interest, except to specialists.

SUB-KINGDOM VERTEBRATA.

FISHES.

The fishes of the Palæozoic ages were either *Ganoids*, like the Gar-pikes, their surfaces covered with strong enameled or plate-like scales ; *Placoderms*, the heads and sometimes the bodies of which were coated with strong bony plates ; or *Sharks*. They are mostly represented as fossils by detached teeth, jaws, plates, fin-spines or scales. Occasionally entire specimens of ganoids are found in the Devonian and Carboniferous, but are not common. In the Mesozoic and Cenozoic ages other forms are found, especially the bony fishes, *Teliosts*.

FIG. 39.—*FISHES.*

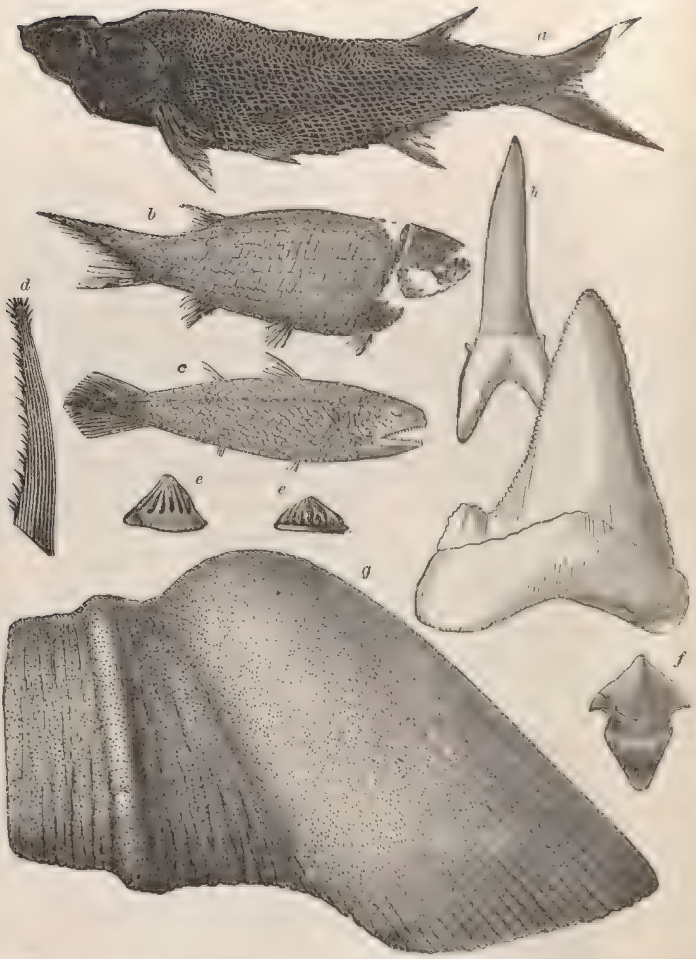


FIG. 39: GANOIDS—*a*, Catopterus gracilis; *b*, Eurylepis tuberculatus; *c*, Cœlacanthus elegans. SELACHIANS, *Sharks*—*d*, Fin spine; *e*, Dermal plates of Petrodus occidentalis; *f*, Tooth of Petalodus destructor. CESTRACIONTS, *Sharks*—*g*, Tooth of Cochliodus nobilis. True SHARKS—*h*, Tooth of Lamna elegans; *i*, Tooth of Carcharodon angustidens.

There are *bones*, *plates*, *spines* and *teeth* from the Upper Helderberg and Hamilton groups on exhibition in Alcove Case No. 7 and scales, bones and jaws with teeth, from the Catskill group in

Case M, Sect. 4, and a fine fin with its connecting bones in Alcove Case 10. Also pavement teeth of Cestraciont and Hybodont sharks in Case M, Sect. 12; Case N, Sects. 4 and 9. A few small fishes, from the Coal Measures, Case O, Sect. 11. Under the Triassic, Case O, Sects. 12 and 13, and Alcove Case 13, will be found a fine collection of fishes from the Connecticut Valley slates. A beautiful series of bony fishes may be seen under the Eocene, in Case P, Sect. 12 from Wyoming; in these the structure is beautifully preserved. Also a few nodules with fishes from the Post Pliocene in Case Q, Sect. 12. And a large collection of shark teeth from the Eocene of South Carolina in Alcove Case 14. In the foreign series there are many beautiful examples of fishes from Solenhofen, Bavaria, in Case R, Sect. 12, and some fine Ganoids in other parts of the Case.

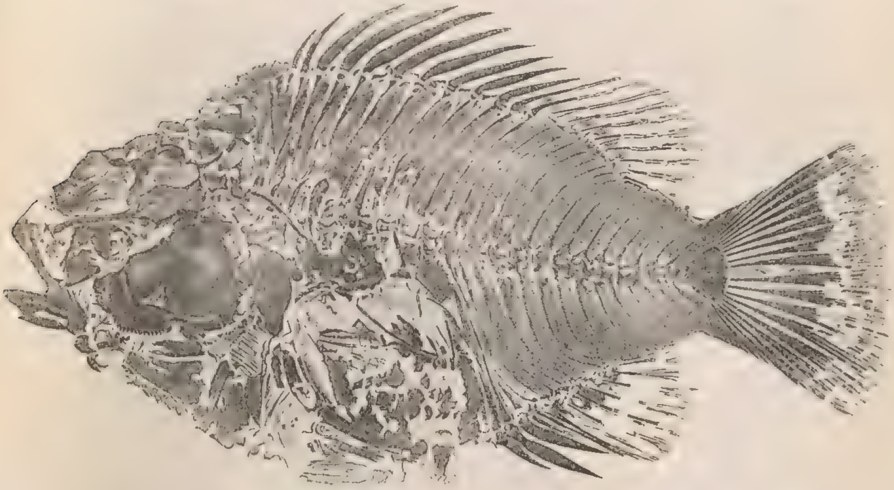


FIG. 40.—Priscacara cypha, Cope Fossil fish from the Eocene of Wyoming (see Case P, Sect. 12), reduced. (After Cope.)

REPTILES.

This group of animals is represented under the Triassic epoch of America, by tracks in red sandstone from the Connecticut Valley. One large slab of great beauty, showing six consecutive tracks of the same individual of *Brontozoum giganteum*, is placed on the landing of the stair leading to the Hall, and others at the south end of the room. Still others of smaller species may be seen in the Triassic, Case O. These tracks were made by large lizard-like animals having the habit of walking on their hind feet. They are called *Dinosaurs* (terrible lizards) and attained immense size. There are also fossil *Turtles* under the Miocene, Case Q, from the Upper Missouri, and a cast of a left femur (thigh bone), from an immense Marine Lizard, *Atlantosaurus*, from the Jurassic of Colorado, in Case O, Sect. 12. In the European collection there are some fine specimens of *Ichthyosaurus* from the Lyme Regis beds of the Lias, in England, Case R, and jaws and teeth of a *Mosasaurus* in Alcove Case 14, and in the case of vertebrates.

FIG. 41.—*REPTILES.*

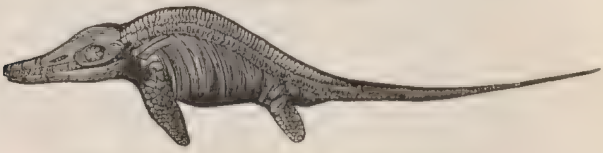
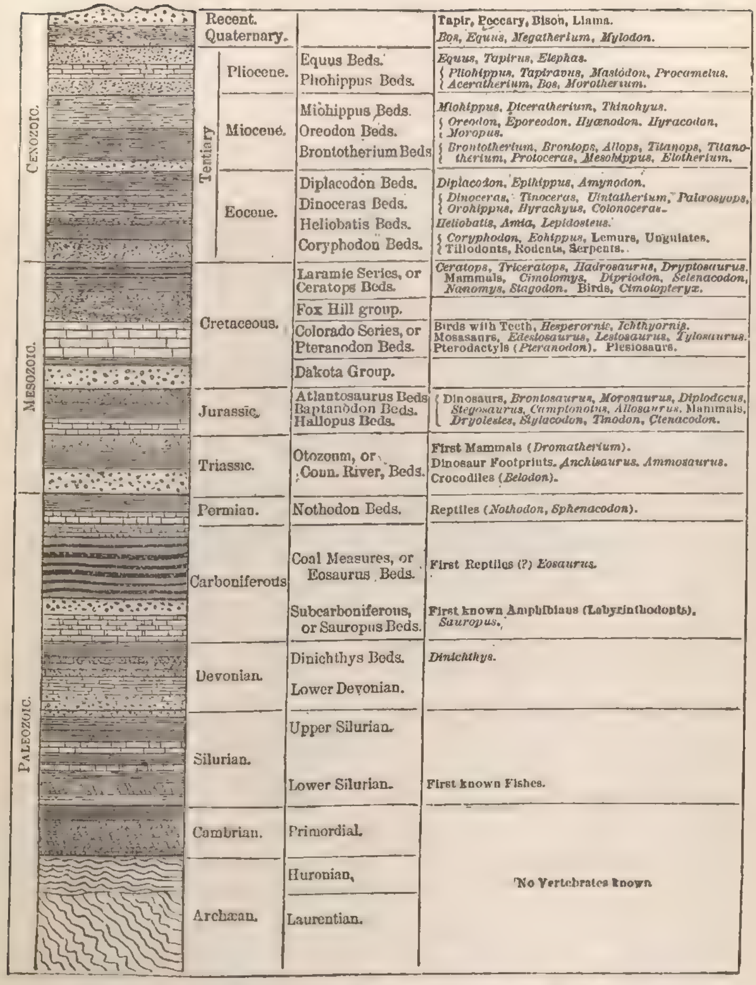


FIG. 41.—Icthyosaurus communis, 1-36 of natural size.

BIRDS.

In the case to the right of the door, as one enters the room, there is a fine series of skeletons of the fossil birds of New Zealand, the MOAS. A larger one occupies the middle of the Hall. These birds were allied in form and character to the ostrich of the present day, but were more completely destitute of wings (Apterous). They are found buried in superficial deposits, under such circumstances as to lead to the belief that they became extinct during the Human period. There are also some bones of the *Dodo*, a large bird of about fifty pounds weight, formerly abundant on the Island of Mauritius, but which became extinct during the early part of the eighteenth century. Also a plaster cast of a fossil egg of *Æpyornis maximus*, another large fossil bird from Madagascar (Case T). There is also a series of casts of the fossil toothed birds from the Cretaceous rocks of the Rocky Mountains, so ably described by Prof. O. C. Marsh, by whom they were presented, in the Alcove Case 13, under the Cretaceous period.



CENOZOIC.	Recent.			Tapir, Peccary, Bison, Llama.
	Quaternary.			*Bos*, *Equus*, *Megatherium*, *Mylodon*.
	Tertiary	Pliocene.	Equus Beds.	*Equus*, *Tapirus*, *Elephas*.
			Pliohippus Beds.	*Pliohippus*, *Tapiravus*, *Mastodon*, *Procamelus*. *Aceratherium*, *Bos*, *Morotherium*.
		Miocene.	Miohippus Beds.	*Miohippus*, *Diceratherium*, *Thinohyus*.
			Oreodon Beds.	*Oreodon*, *Eporeodon*. *Hyænodon*. *Hyracodon*, *Moropus*.
			Brontotherium Beds	*Brontotherium*, *Brontops*, *Allops*, *Titanops*, *Titanotherium*, *Protoceras*, *Mesohippus*, *Elotherium*.
		Eocene.	Diplacodon Beds.	*Diplacodon*, *Epihippus*, *Amynodon*.
			Dinoceras Beds.	*Dinoceras*, *Tinoceras*, *Uintatherium*, *Palæosyops*, *Orohippus*, *Hyrachyus*, *Colonoceras*.
			Heliobatis Beds.	*Heliobatis*, *Amia*, *Lepidosteus*.
			Coryphodon Beds.	*Coryphodon*, *Eohippus*, Lemurs, Ungulates. Tillodonts, Rodents, Serpents.
MESOZOIC.	Cretaceous.		Laramie Series, or Ceratops Beds.	*Ceratops*, *Triceratops*, *Hadrosaurus*, *Dryptosaurus*. Mammals, *Cimolomys*, *Dipriodon*, *Selenacodon*, *Nanomys*, *Stagodon*. Birds, *Cimolopteryx*.
			Fox Hill group.	
			Colorado Series, or Pteranodon Beds.	Birds with Teeth, *Hesperornis*, *Ichthyornis*. Mosasaurs, *Edestosaurus*, *Lestosaurus*, *Tylosaurus*. Pterodactyls (*Pteranodon*). Plesiosaurs.
			Dakota Group.	
	Jurassic.		Atlantosaurus Beds Baptanodon Beds. Hallopus Beds.	Dinosaurs, *Brontosaurus*, *Morosaurus*, *Diplodocus*, *Stegosaurus*, *Camptonotus*, *Allosaurus*. Mammals, *Dryolestes*, *Stylacodon*, *Tinodon*, *Ctenacodon*.
	Triassic.		Otozoum, or Conn. River, Beds.	First Mammals (*Dromatherium*). Dinosaur Footprints. *Anchisaurus*. *Ammosaurus*. Crocodiles (*Belodon*).
PALEOZOIC.	Permian.		Nothodon Beds.	Reptiles (*Nothodon*, *Sphenacodon*).
	Carboniferous		Coal Measures, or Eosaurus Beds.	First Reptiles (?) *Eosaurus*.
			Subcarboniferous, or Sauropus Beds.	First known Amphibians (Labyrinthodonts). *Sauropus*.
	Devonian.		Dinichthys Beds.	*Dinichthys*.
			Lower Devonian.	
	Silurian.		Upper Silurian.	
			Lower Silurian.	First known Fishes.
	Cambrian.		Primordial.	No Vertebrates known
	Archæan.		Huronian,	
			Laurentian.	

SECTION TO ILLUSTRATE VERTEBRATE LIFE IN AMERICA.

FIG. 42.

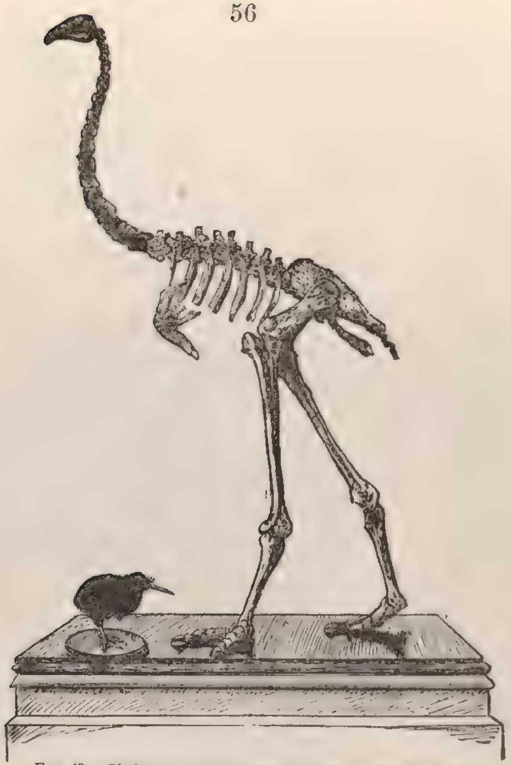


FIG. 43.—Skeleton of Moa, a fossil bird from New Zealand.

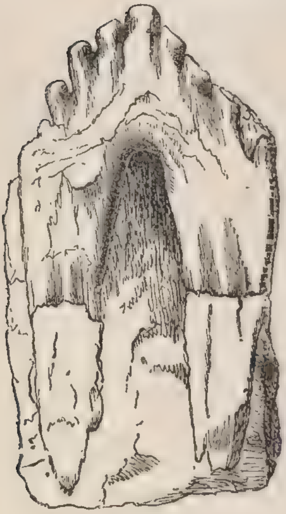


FIG. 44.—Tooth of Zeuglodon cetoides (×⅝).

MAMMALIA.

CETACEANS.

The Cetaceans (*Whales*) are represented in the collection by joints of the vertebra of *Zeuglodon Cetoides* in the front of Case P, and a tooth of the same in the *Dana's Manual* series, Alcove Case 14. There are also ear bones of Whales and some fragments of jaws of *Squalodon Tiedemani*, Allen, from South Carolina, in Alcove Case 14.

UNGULATA. (*Hoofed Mammals.*)

This group includes the following suborders represented in the collection by fossil forms :

PERISSODACTYLA....odd-toed ungulates, as Horse, Tapir, Rhinoceros, &c.
ARTIODACTYLA.....even-toed ungulates, as Deer, Sheep, Ox, &c.
PROBOSCIDIA.......Elephant, Mastodon, &c.
AMBLYPODA........heavy-footed ungulates, as Dinoceras, Coryphodon, &c.
CONDYLARTHRA....primitive ungulates, as Phenacodus (see cast in hallway).

CONDYLARTHRA (*primitive ungulates*). — This suborder is represented by a cast of *Phenacodus primævus* Cope, presented by Dr. Robert H. Lamborn, in the hallway at the north end of the room. It was of about the size of a Sheep, but possessed five complete toes on each foot. It pertains to the Eocene period. There are also jaws, teeth and feet in the case of vertebrates in the body of the room.

AMBLYPODA.—Remains of a very ancient and remarkable form called Coryphodon, from its yoked-shaped teeth, are shown in the large case. It resembled the Bear in its walk, but the limbs, although short, were as heavy as those of the Rhinoceros. Of one skeleton there are shown the complete fore and hind feet, the limbs and pelvis. Also many of the teeth of different individuals.

PERISSODACTYLA (*odd-toed ungulates*). — These forms are characterized by the middle toe being larger than the others, like the Horse, whereas the outer toes are nearly obsolete. Among the earliest to appear were the ancestral tapirs (*Systemodons*), see specimens in large case.* There are also shown the lower jaws of the earliest of the Horses (*Hyracotherium*), and a restoration of a complete five-toed Horse (*H. venticolum*) no larger than a Fox. The later horses are also represented by the teeth and skulls of *Mesohippus* from the Miocene of the Judith River (Case Q, Sect. 6), which is intermediate in its characters between *Hyracotherium* and the modern Horse. There is also, in the large case, the fore foot of Palæosyops, an ancestor of the great *Titanotherium* (=*Menodus*) and in Case Q, Sects. 6 and 7, jaws, teeth and many separate bones of the skeleton. A group of hornless Rhinoceroses is represented by jaws and teeth of *Aceratherium*, and jaws, skulls and limb bones of *Hyracodon*, in Sects. 4, 5 and 6 of Case Q.

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* Many of these Mammalia are placed temporarily in the front of Case S.

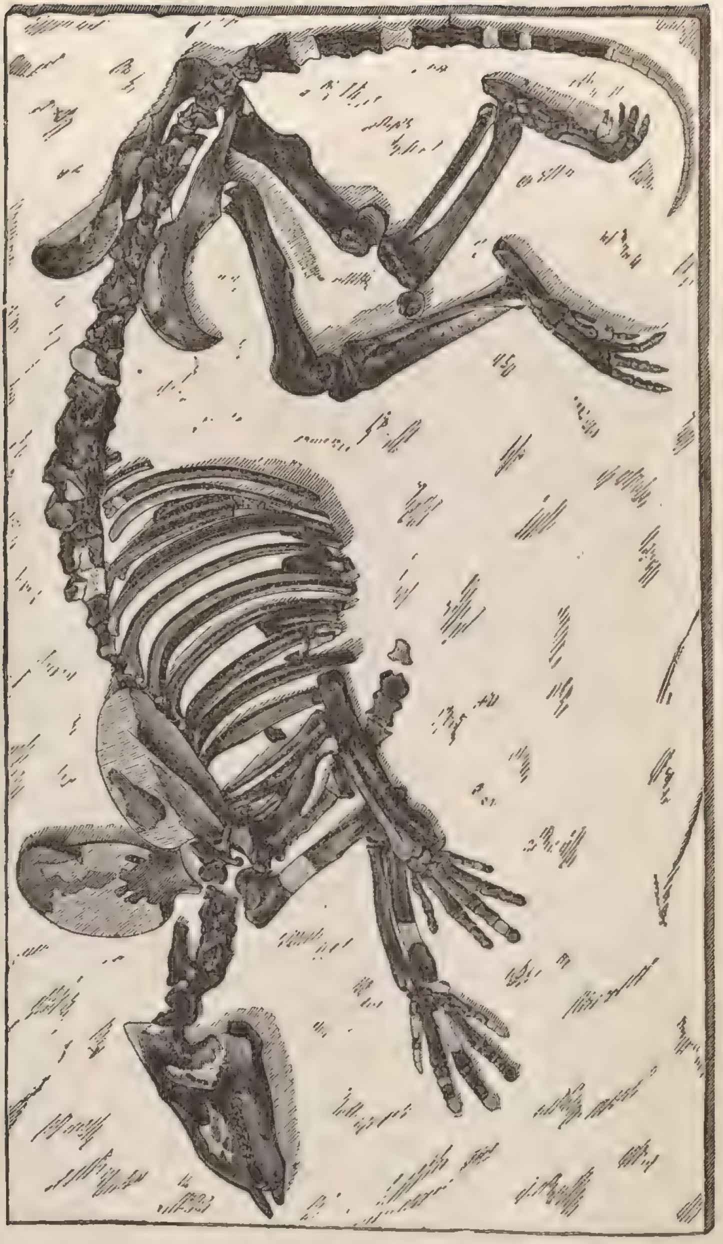

FIG. 45.—*Phenacodus primævus* Cope. ⅛ nat. size.

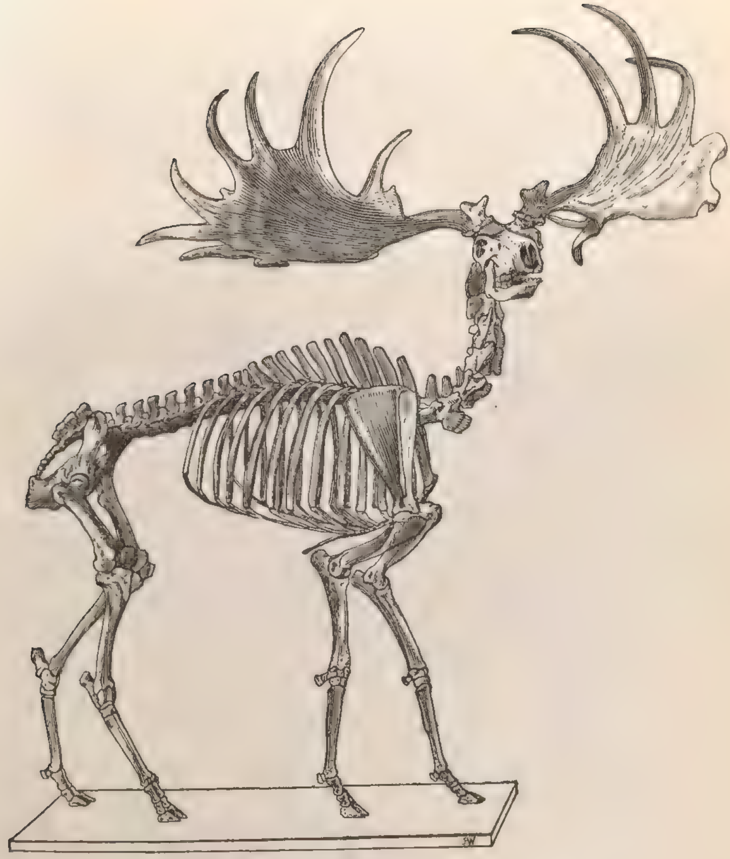

FIG. 46.—Skeleton of Irish Deer.

ARTIODACTYLA (*even-toed ungulates*).—This group is characterized by having two large central toes divided in the middle (*the cloven hoof*), like the Hog, Sheep, Deer and Ox. Representing these is the very small jaw of *Pantolestes*, from the Eocene of Wyoming, in the large case. Also many skulls, teeth and bones of *Oreodon*, a much later form, in Case Q, Sects. 3 and 4, from the Miocene of the Judith River region. This animal resembled the Deer in its teeth; but in form, size and character of feet, resembled the Mexican Peccary. There are also skulls, jaws and teeth of a larger form, *Entelodon*, also distinctly related to the Hog, in Sect. 8 of the same case, and from the same region.

Of the true *Ruminants*, the skeleton of the Irish Deer, *Megaceros Hibernicus*, is a fine representative. This animal probably became extinct since the advent of man.

PROBOSIDIA (*having a flexible trunk*).—This group is represented by the Mastodon, and by teeth and bones of the fossil Elephant, *Elephas americanus.* See Case Q, Sects. 12 and 13.

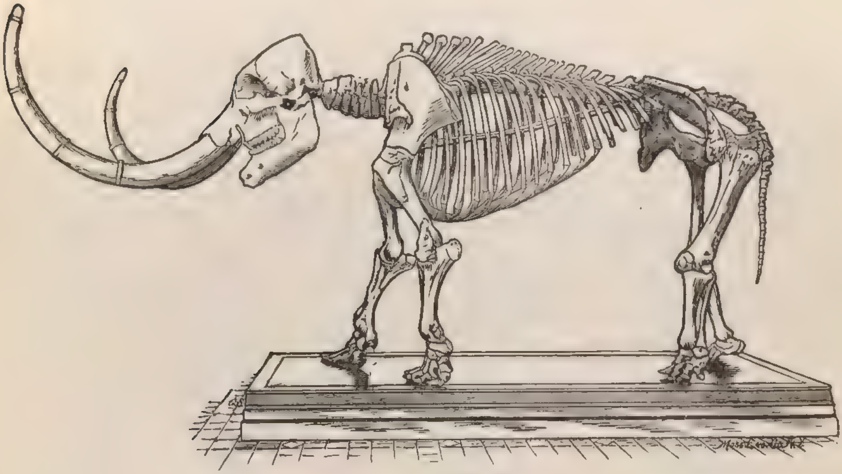

FIG. 47.

SKELETON OF MASTODON GIGANTEUS, *Cuvier.*

The Mastodon, an animal closely resembling the Elephant in general appearance, but proportionally heavier and more stocky, was at one time a common inhabitant of this country, but became extinct probably several thousand years ago. The bones, when many of those of one individual are found together, always occur in peaty swamps or bogs, or in places where they may have become mired or drowned. But sometimes isolated bones or teeth are found in gravel or marly deposits, and have, in such cases, been transported from their original bed by water or ice action.

The bones of the skeleton in the Museum were found imbedded in peaty material on the edge of what was, less than fifty years before, an open pond of considerable size, subsequently drained and brought under cultivation, situated in the town of Little Britain, about nine miles southwest of Newburg, N. Y., and at the time of their discovery, cultivated as a potato field. In digging a ditch, twenty inches deep, to more completely drain this spot, consequent upon the wet season of 1879, an apparent log was reached at a depth of fourteen inches, which proving too hard for a dull axe, was dug out, and found to be the leg bone of an animal.

This induced the farmer to search for other bones, and after a few days, more than one-third of the skeleton had been exhumed, including the head. Three weeks after I visited and examined the place and bones, at the request of Major T. B. Brooks, of Newburg. The swamp is bordered on the side nearest the position of the skeleton by a low hill of "boulder clay," a hard, blue clay mixed with gravel, which slopes down and passes under the peat or "muck" of the swamp, and forms the original bottom of the pond.

The skeleton was found with the head farthest from the margin, and deeply imbedded; while the right limbs were near the surface (the right humerus only fourteen inches deep), proving the animal to have been mired, and to have fallen on its left side. Where the head was found, twenty feet from where the clay rises to the surface, the peaty material was ten feet deep above the clay, and where the humerus was first struck the depth was less than three feet. Owing to this fact, these bones, which were so near the surface, are less perfectly preserved.

Skeletons of Mastodon, like those of other fossil animals, are seldom found entire, more or less of their parts having decayed; consequently the missing parts have to be replaced, either by the substitution of the missing bones from other individuals of corresponding size, or by artificial models. The skeleton in question is probably the most perfect of the mounted skeletons now known, except the famous Warren Mastodon, found near Newburg in 1845, and now in the Warren Collection at Boston, Mass., of which the tusks, all but one of the sternal (breast) bones, many of the bones of the feet and the caudal bones, are artificial.

In the present skeleton the tusks are replaced by a pair from Hoopeston, Ill., belonging to the same individual as the separate lower jaw, with tusks; the pelvic bones and three of the ribs are also substituted. These parts had probably decayed from their nearness to the surface, or were plowed up in cultivating the ground. The terminal bones of the feet, four of those of the neck, three of the back, and all but the upper six of the tail, are modeled in *papier maché*. A portion of the right shoulder blade (scapula) is also restored. All other parts are from the one animal.

DIMENSIONS OF THE SKELETON.

Extreme length to the anterior curve of tusks, .	18 ft.	
Extreme length to end of tusk sockets, . .	14 "	
Height to top of dorsal spines, ...	8 "	6 in.
Breadth across hip bones (pelvis), . .	5 "	
Length of tusks along outer curve, . . .	7 "	5 in.

The height of a skeleton is readily varied by the manner of mounting it. The height here might be increased twelve to eighteen inches by raising the body between the shoulder blades, as is usually but wrongfully done.

GENERAL APPEARANCE OF A MASTODON.

The general appearance of a Mastodon while living, would, as stated above, be much like that of a living Elephant. The skeletons of the two differ only in the dentition (teeth) and in the less height and more heavy limb bones of the Mastodon. The Elephants' teeth are larger, and only one on each side of each jaw at a time, fully developed; the remnants of the old, worn-out tooth, being pushed out of place by the advance of the new one. They are, moreover, constructed of flattened, vertical cylinders of enamel, filled within and surrounded and encased by ivory-like cement; the motion of the jaws being such as to rub the teeth together, wears them down to nearly flat surfaces. On the contrary, the Mastodon teeth are two on each side of each jaw, and are made up of ivory cement in the inside, covered with a thick coating of enamel, while the surfaces are covered by strong, tubercular ridges, resembling the teats of a cow, whence the name *Mastodon*. The motion of the jaws does not produce a rubbing of the teeth, but is fitted for crushing the coarser vegetable substances. It also has tusks in the lower jaw until nearly or quite adult, in both sexes; and in the males, one or sometimes both sides permanently; in which respect they differ entirely from the Elephant.

The comparative age of the Indian Elephant can be arrived at from the size of the teeth and the number of plates they contain.

The number of teeth in each side of each jaw is supposed to be six, following in succession, one behind the other. The first one has four to six rings or plates; the second, eight or nine; the third, eleven to thirteen; the fourth, fifteen or sixteen; the fifth, seventeen to twenty; and the sixth, twenty-two to twenty-seven. In the Mastodon the number is the same, six; and the comparative age is recognized by the number of tubercular ridges, and the size and form of the crown. The first and second had but two ridges, the latter larger in size; the third in succession had three ridges and was narrowed in front; the fourth had three ridges, but was of equal width at the ends; the fifth had three ridges only, was widest behind and with long fangs; the sixth tooth had four ridges and a heel, or imperfect fifth ridge. The comparative time the last tooth had been in use is recognized by the degree of wearing it has undergone. Teeth representing some of these stages in the Mastodon can be seen in Case Q, Sect. 13.

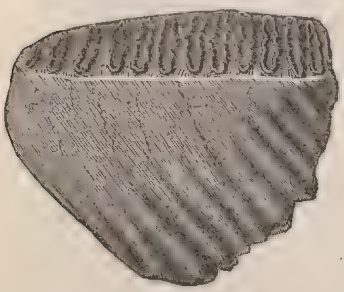

Fig. 48.—Tooth of Elephas Americanus (×¼).

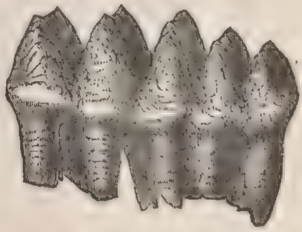

Fig. 49.—Tooth of Mastodon giganteus (×¼).

UNGUICULATES. (*Clawed Animals.*)

This group includes the Carnivores or flesh-eaters, and is divided into Creodonta, *ancient carnivores*, and Carnivora, *living carnivores.*

The *Creodonts* all belonged to the lower Eocene period. They are represented in the large case by teeth and jaws of two species of *Pachyæna*. One of these, *P. gigantea*, is the largest known form of these animals, having been about as long as the Grizzly Bear but with a more slender body. Another form, *Palæonictis*, was of the size of the American Puma or Panther. There are also jaws, teeth and parts of the skulls of Hyænodon, which was intermediate in structure between the Hyæna and Wolf, and was the last of the ancient type of Carnivores.

The true *Carnivora* are represented, in Case Q, Sects. 8 and 9, by the jaws and teeth of *Drepanodon*, and by skulls and jaws of *Dinictes*, which were small tiger-like forms.

"DANA'S MANUAL" SERIES.

In the ends of the Alcove Cases is arranged a series of fossils to illustrate the American portion of *Dana's Manual of Geology*, as far as the collection contains them, or specimens can be obtained. A large part of the species exhibited in the series are the very ones from which the figures were taken, and the others, authentic representative specimens of their species. On the label will be found the name of the species, and that of its author; the page of the *Manual* where figured, and the number of the figure representing it; the group of plants or animals to which it belongs, and the locality whence obtained. There is also a copy of *Dana's Manual of Geology* kept in Alcove No. 2, for the use of visitors who wish to consult its pages. This series will be of particular benefit to students of geology, by allowing them to see a specimen of the species illustrated in the *Manual* or *Text Book*, which will enable them to form a much clearer idea of the object than can be obtained from the figure alone. In many cases the actual specimen from which the figure was originally made is placed in the series. This feature is one never before attempted in any collection or museum.

GEOLOGICAL CHARTS AND RELIEF MAPS.

On the walls of the room are several geological Maps and Charts, the latter showing the succession of epochs and giving their comparative thickness in America, and also indicating by the color used their prevailing lithological character. On the top of the cases, each side of the northern door, relief maps are exhibited which show the topographical features and geological structure of the districts represented. Each color represents a geological formation, and shows the area over which it is known to be the surface rock beneath the covering of sand, gravel, clay, &c. The large relief map of New Hampshire in the first alcove on the east side is also colored geologically, so as to represent the geology of the State. The series of maps of the eastern part of North America also show approximately the extent of land above the sea at the close of the geological period last added, and consequently the geography of that time. The series when taken together also shows the gradual increase of the continent during the successive periods.

COLLECTION OF BUILDING AND ORNAMENTAL STONES.

There is a collection of American building stones arranged in cases in the hallway of the lower floor of the new building, at the foot of the main stairway. It contains 1,050 blocks principally four inch cubes, polished on the face, and variously dressed on the other sides. The specimens represent nearly every State in the Union, and contains samples of all grades of Granite, Sandstone, Limestone, Marbles, Slates and other rocks used for building and ornamental or monumental purposes. Each of these samples is accompanied by a label giving the name of the quarry, that of the person or company working it, the location, name of the material and the geological position. The collection is at present arranged geographically under the different States, and each specimen is numbered and catalogued, and may be consulted and examined by interested persons on application to the Curator of Geology. This collection is a duplicate of that used by the experts employed on this department for the "Tenth Census Report," and has been made at great expense by Mr. Morris K. Jesup. There is also a slide prepared for microscopic study belonging to each block in possession of the Museum, many of which were reported on in the "Tenth Census Report." The catalogue of this collection has been published in the magazine "Stone," published at Indianapolis, Ind., devoted to the interest of stone quarrying and working. Vol. 1, No. 7 Nov., 1888.

Besides the above collection there are numbers of larger blocks of American and foreign building stones, marbles, &c., at present arranged around the hallway adjoining, many of them being of great beauty. Of many of these the locality is unknown, the labels and records having been lost or destroyed at the Centennial Exposition, from whence most of them were obtained.

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